

Chemical & Process Engineering

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Topics of the Month

More endorsement for the Cremer report

IN their recently published report for 1951-52 the Department of Scientific and Industrial Research again endorse the conclusions of the Cremer report on chemical engineering: that the national interest demands the creation of a central chemical engineering research organisation. Further action, of course, awaits the findings of Major F. H. Bramwell who, as reported in these notes last November, has been appointed jointly by the Association of British Chemical Manufacturers and the British Chemical Plant Manufacturers' Association to investigate the chemical engineering needs of the chemical and chemical plant industries in the light of the Cremer report. According to the D.S.I.R. report, he is making a detailed study of information already available in industrial research establishments and the resources of those establishments for carrying out further investigations. Again, according to the report, this study, dependent on the findings, may be followed by the setting up of a properly staffed documentation unit. It is expected that the survey will be completed in six to twelve months.

Recently, in the House of Commons, the Government was asked what action had been taken on the Cremer report. The Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the Council, replied giving much the same information as above. An additional interesting point, however, was that the Advisory Council

for Scientific and Industrial Research had also endorsed the view that a central chemical engineering research organisation was needed. Major Bramwell's findings will apparently decide whether industry will set up this organisation itself or whether 'some other means of meeting the requirement for research in this field will have to be found.'

European water de-salting research

DEMINERALISATION of salt waters, the subject of an article in our April issue, is made even more topical by the news that the Organisation for European Economic Co-operation has set up a working party to study this question. Our article, which was based upon information issued by the Saline Water Research Programme of the U.S. Department of the Interior, describes no fewer than 16 potential separation processes and phenomena under three heads: physical, chemical and electrical processes and phenomena. The European working party, in which the U.K.'s Department of Scientific and Industrial Research is interested, is concentrating current study on four processes: ion exchange, separation by freezing, electrolysis and vapour compression distillation. A group of experts has been appointed to investigate these processes and from their conclusions the working party will decide which process or processes call for work on a development scale. The most promising appears to be vapour compression distillation.

However, the working party should soon have its experts' report. Waters of 1,000, 5,000 and 20,000 p.p.m. chloride content have been considered.

The process or processes recommended by the experts will be available for co-operative development by countries of the O.E.E.C., including the U.K. These countries will be free to collaborate or not, as they choose. Those co-operating would, of course, share in the rights of any successful process which may result. We understand that so far there is no plan for co-operation with the American Saline Water Research Programme.

The idea of the O.E.E.C. working party on de-salting was originally suggested by the Netherlands. In that country the underground water level is falling and the water getting brackish. Although de-salting is not yet a serious problem in Britain, there is a tendency for certain London supplies to become slightly brackish. In the next ten years this may assume more importance. In other countries such as the West Indies, Pakistan and South Africa, where water supplies are short or are likely to become so, de-salting will have to be resorted to in the fairly near future. Provision of the necessary plant will open new markets for the chemical engineering industries.

Asian coal and iron ore resources

CONSIDERABLE efforts have been made in the last few years by Asian countries to develop coal and iron ore resources: indigenous industries have been started, production increased, the quality of low-grade deposits improved, and the conservation of higher-grade deposits facilitated.

These observations are made in a detailed study—the first of its kind—published by the United Nations Economic Commission for Asia and the Far East. The report is the result of a two-year research and on-the-spot investigations undertaken by E.C.A.F.E.'s staff in co-operation with a great number of government and other experts from Asian countries.

E.C.A.F.E.'s mineral resources experts emphasize the importance of coal and iron ore for the sound planning of industrial development and give facts and figures—never published before in such comprehensive form—showing how inadequately explored for coal and iron ore the Asian region is.

The report estimates that the known coal reserves of Asia and the Far East total some 557,000 million tons, of which 445,000 million tons are in China, 68,000 million tons in India and 20,000 million tons each in Indo-China and Japan.

Of the total known iron ore reserves of the region, estimated to be almost 11,000 million tons, over 78% are in India and China (5,087 and 4,168 million tons respectively), with the Philippines (1,019) and Indonesia (899) being next in importance. Japan ranks as a rather poor fifth with some 170,000 million tons.

The report gives striking examples of the inadequacy of mineral resource surveys. In China it has been estimated that, with the present strength of technicians, it would take at least 15 years to complete a geological survey of the country on a scale of 1: 200,000. In India, 300,000 square miles of the accessible parts remain to be geologically mapped on the 1 in. to 1 mile scale, the smallest scale of practical use.

In Indonesia only 8% of Java has been geologically surveyed on a scale of 1: 100,000 and 8% of Sumatra on a scale of 1: 200,000. In the Federation of Malaya, geological maps on a scale of 1 in. to 1 mile are available only for 3.5%

of the whole country. Only 5% of Korea and less than 10% of the Philippines have been surveyed on a scale of 1: 50,000. In Thailand, though a general geological map on a scale of 1: 2,500,000 is now available, no detailed surveys have so far been made.

The implication of these facts is that there are still vast reserves of raw materials awaiting exploitation and that current estimates of total global resources are likely to be seriously in error.

Atom separator

VALUABLE new atomic research materials are now being provided by the Ministry of Supply's establishment at Harwell to scientists in Great Britain, the Commonwealth and Europe. Machines known as electromagnetic separators which are being used for this work can not only separate the atoms of an element one from another but can reassemble them into usable quantities. Atoms of elements may differ in weight; by separating those which are heavier or lighter than normal much important research work becomes possible.

There are two electromagnetic separators at Harwell. With the aid of many ingenious electronic controls, the bigger one has been made largely automatic. So far 20 elements, including most of the common metals, have been separated into their constituent isotopes (or atoms of different weight), these being boron, lithium, carbon, magnesium, silicon, calcium, titanium, vanadium, chromium, iron, nickel, copper, zinc, germanium, krypton, strontium, cadmium, indium, tin and antimony. Other elements, among them sulphur, selenium, potassium, rubidium, zirconium, molybdenum, silver, barium, tungsten and certain of the rare earths, are to be included in the programme.

These materials are widely sought after by scientists, and about 200 consignments have been either used at Harwell or sent to research institutions and universities in the British Isles, the Commonwealth and Europe. About 60 different isotopes are in stock to meet future requests.

Separated isotopes are essential for the study of certain nuclear reactions. This work involves the bombardment of elements with various high-speed particles and examinations of the scattered radiation. It is much simpler to work with the isotopes rather than with the natural mixture. Fundamental nuclear and physical properties of isotopes can be much more simply and accurately determined with the separated isotopes now available and such information is vital for the atomic energy programme and for the development of theories of nuclear structure. Stable isotopes also aid the application of pile-produced radioactive tracer isotopes; for instance, enriched iron 59 which is required for medical research can be made free from the undesirable iron 55 isotope by irradiating separated iron 58 instead of natural iron. In a similar way, calcium 45 made by starting with enriched calcium 44 provides a more efficient tracer than the material made from the natural element.

There are many other applications of separated stable isotopes and the availability of these materials frequently promotes new ones. In particular, it may be of interest to mention spectroscopic studies, which are greatly simplified by the use of single isotopes; the feasibility of setting up more accurate wavelength standards in the spectral line by the use of separated isotopes of certain elements such as cadmium; the study of the strange phenomenon of 'superconductivity'; and the chemical analysis of very small traces of impurities.

Cement and cement machinery in India

PERHAPS the most spectacular progress of any industry in India has been achieved by the cement industry. Forty years ago it did not exist. Today there are 22 factories with an output of between 3.3 and 3.8 million tons p.a. Expansion is going on apace and it is expected that total output will reach 6 to 7 million tons p.a. in 1956. The two giants of the industry are the Associated Cement Companies Ltd., which recently opened a new factory at Sevalia with a capacity of 200,000 tons p.a., and the Dalmia Group.

One trend in the Indian cement industry of considerable significance for plant manufacturers has been the development of cement machinery manufacture by the A.C.C. According to a review of the industry in the *Industrial Review*, the need to make cement machinery arose during the war when imports were seriously curtailed. The A.C.C. met the problem by starting fabrication of machinery in its own workshops. Today these workshops have been enlarged and are turning out such equipment as hammer crushers, rotary kilns, raw tube mills, cement tube mills, etc. Thus the Indian cement industry has gone a long way towards self-sufficiency in heavy machinery for equipping new factories and renovating existing ones. However, such items as power plants, large-capacity electric motors, switchgear, speed reduction gears, etc., must still be imported.

The A.C.C. has also taken the lead in cement research. It has made plans for a Research Centre for Cement and Concrete for the continuous development of improved and new products. The company's latest product is a low-heat cement particularly suitable for the building of dams.

New chapters in the Canadian chemical story

THE decision of Imperial Chemical Industries to build a \$20-million plant for *Terylene* manufacture at Millhaven, Ontario, which is reported on another page, adds a new chapter to the remarkable story of Canadian chemical expansion which has been frequently commented on in these notes. Synthetic fibres, petroleum chemicals, plastics and phosphorus are among the products which will be made in plants now being built in Canada by domestic, British and American interests. Already Shell Oil Co. of Canada has started production of isopropyl alcohol at its recently completed petroleum chemicals plant in Montreal East. The plant, which is operating on refinery gases and cost over \$3.5 million, will have a capacity of 20 million lb. p.a. (12 million isopropyl and 8 million acetone).

Bakelite (Canada) Ltd. has just begun the first Canadian production of formaldehyde at its million-dollar Belleville plant. With an annual capacity of some 30 million lb. p.a.—about the same as current Canadian consumption—the company intends to use about half the output to produce phenolic formaldehyde resins and urea formaldehyde products. The rest will be sold to other consuming industries.

B. A. Shawinigan Ltd. will shortly start producing synthetic phenol in Canada for the first time at a \$4-million plant in Montreal East. This is expected to make the country independent of imports. Acetone will also be produced.

The Dominion Tar & Chemical Co.'s new Montreal East plant, costing about \$10 million, will have a capacity of 30 million lb. p.a. of ethylene glycol. It will also produce some ethylene oxide. It is to begin operations this month (May).

St. Maurice Chemicals will also bring its new \$3-million plant at Varennes, Quebec, into production this month. It will have an annual capacity of 30 million lb. of formaldehyde and 2 to 3 million lb. of pentaerythritol.

Dow Chemical's new \$4-million styrene monomer plant is also due to start operations this month. Monthly capacity will be 2 million lb.

Canadian Resins & Chemicals' plant at Shawinigan Falls is expected to start making vinylite film and sheeting in a matter of weeks. A \$2- to \$3-million vinyl resin plant is expected to start production later this year.

The Canadian Chemical Co.'s \$55-million plant is to produce cellulose, acetate, yarn and fibre and some industrial chemicals including formaldehyde, pentaerythritol and acetaldehyde.

The Electric Reduction Co.'s \$5-million phosphorus plant at Varennes is scheduled to begin production in October. It will be the only one of its kind in Canada.

Finally, Canadian Industries Ltd.'s \$20-million plant will start the first Canadian production of nylon intermediates at Maitland, Ontario, in the third quarter of the year. It should make Canada largely self-sufficient in this product. C.I.L.'s \$13-million polyethylene plant at Edmonton will also come into operation late this year. The peak annual capacity of 12 million lb. will be in excess of anticipated consumption, but markets are expanding.

Chemical engineering and food research

THE chemical and mechanical engineer have an important part to play in food research. The three processes for the preservation of foodstuffs—refrigeration, canning and drying—which are the main concern of the Department of Scientific and Industrial Research in food investigation, provide their own problems of heat and water transfer and of plant design and efficiency. Dr. Franklin Kidd, F.R.S., Director of the Food Investigation Organisation, D.S.I.R., in his picture of the work and objectives of the organisation given in a paper presented to the Food Group of the Society of Chemical Industry, touched frequently on the chemical engineering aspects of food research.

The work of the organisation has always included a section for physics and engineering applied to the improvement of food handling and storing methods. Three research laboratories have been established: the Cambridge Low-Temperature Research Station, the Torry Research Station at Aberdeen and the Ditton Laboratory near Maidstone. Work at Ditton has been designed to improve the storage of potatoes, the storage of dessert apples and the methods of distribution of soft fruits and vegetables.

Experimental work in the gas-storage field has been carried out as well as research on dehydration of vegetables. In this problem of storage, the study of the volatile products which are given off by fruit and vegetables and which accumulate in storage atmospheres is an important item. That rotting by micro-organisms could be checked by volatiles added to the atmosphere of a store was discovered at the Cambridge L.T.R.S. Diphenyl was successful for oranges and has been used in Palestine. Orthophenyl phenol was found to check decay in stored eggs. To check the sprouting of potatoes, dichlor-nitrobenzene and benzoates were effective, and developments from these beginnings have since taken place. Carbon dioxide, which stimulates sprouting in potatoes, must be removed. The work on volatiles is not easy and here the chemical engineer

plays his part. The use of ozone radiations and filters for regulating the volatile content of storage atmospheres is being investigated.

The most important factors in wastage are concerned with time and temperature, and the latest addition to this project is a mobile cold store for investigating and demonstrating the advantages of the immediate removal of field heat from produce before shipment to markets.

At the Torry research station, which deals particularly with the fish industry, the buildings and staff have been increased, a new research vessel has been designed and ordered and recently a new laboratory, the Humber Laboratory, was opened near the ports of Grimsby and Hull. Voyages have been made on distant water trawlers to study the limiting factors which any system of freezing at sea on vessels must encounter. The engineering section has designed and installed trial equipment on the station's research vessel. This equipment consists of a battery of vertical plates which freezes whole fish in blocks several inches thick. After freezing, the plates are moved apart mechanically and the blocks discharged vertically. Using this equipment, various physical and engineering problems are being tackled before designing larger equipment.

It is the objective of one group of researchers at the Low-Temperature Research Station to discover the mechanism of the action on plant metabolism of CO_2 and of ethylene, the first of which retards while the second accelerates ripening. A pilot plant for the preparation of ascorbic acid concentrates from lucerne on ion exchange columns is being set up. The importance of ascorbic acid in the food of humans is well known. Although the organic chemist can make ascorbic acid, this has not altered our fundamental dependence upon plant food for this vitamin. Recent work is thought to have demonstrated experimentally the route by which hexose is transformed into ascorbic in the plant or in the animal body.

Experimental work is also being carried out on the effect of controllable variables on the growth and survival of bacteria. In the late '30s the L.T.R.S. began the study of the killing effect of ionising radiations upon bacteria, and today this treatment is receiving renewed attention as potentially an alternative means for sterilising foods. It now seems certain that side effects which result in off-colours and flavours can be reduced by various means such as low temperature during irradiation, exclusion of oxygen, and addition of protective compounds such as ascorbic acid.

Gasworks liquor as a fertiliser

CRUDE gas works liquor containing 1 to 2% of ammonia is a valuable fertiliser which can be applied directly to the land. Although this practice has been carried out on the Continent for many years, until comparatively recently it has not found favour in Britain. As there are 800 small gas works in England and Wales without a sulphate plant, this refusal to use their liquor directly has meant an annual loss of nitrogen of 15,000 tons or more. According to a correspondent in the *Times*, this waste is likely soon to be substantially stopped. The Southern Gas Board has set an example by persuading farmers to buy nearly a million gallons of crude liquor last year for fertiliser. The liquor has been used successfully on one farm for four years. This farm has used the total output of the local gas works with beneficial results not only to crops (grass, cereals and roots) but also to the soil structure.

The Portsmouth gas works has set up a service whereby farmers may telephone instructions to the local manager for treatment of particular fields. Thus, farm labour is spared. The liquor is usually applied from a tractor-drawn tank with a distribution bar. Now a firm is designing a simple drill for sub-surface application of the liquor which should prove useful for market garden crops.

Thermodynamics pioneer

THE bicentenary of the birth of that fascinating figure in the history of science, Benjamin Thompson, better known as Count Rumford, is being honoured by the Massachusetts Institute of Technology, which is arranging a special summer programme on the thermodynamics of equilibrium and non-equilibrium states for next month. Among the special lecture topics which will be given by members of the M.I.T. faculty will be a biography of Rumford.

Rumford is perhaps best remembered as the co-founder, with Sir Joseph Banks, of the Royal Institution of London, which received its royal charter in 1800. Because he made his reputation in Europe, particularly in England, it is sometimes forgotten that Rumford was born in America at Woburn, Massachusetts. He was the son of a New England farmer and he showed early promise of brilliance. At the age of 14 he had advanced far enough 'in algebra, geometry, astronomy and even the higher mathematics, to calculate a solar eclipse within 4 seconds of accuracy.'

In his early teens he was apprenticed to a storekeeper, but his fortunes changed when at the age of 19 he married a prosperous widow of 33. It was about this time that he entered military service. Sent to England for diplomatic reasons in 1776, he entered the service of Lord George Germain, Secretary of State. In about four years, he was made Under-Secretary. During this time he never relinquished his interest in scientific matters and in 1779 was made a F.R.S. Among the subjects which engaged his attention were the explosive force of gunpowder and the construction of firearms.

On the resignation of Lord North's administration he left the civil service and became a soldier again. At Strassburg he met Prince Maximilian of Bavaria, who offered him a post in his government. Accordingly, after receiving a knighthood from George III, he spent the next 11 years in the service of the state of Bavaria, as Minister of War, Minister of Police and Grand Chamberlain. He reorganised the Bavarian army and effected many social reforms, earning a considerable reputation as a philanthropist. When, in 1791, he was created a Count of the Holy Roman Empire, he chose the title of Rumford in honour of his wife's home town. In 1798, having returned to England to live as a private citizen, he presented to the Royal Society his 'Enquiry concerning the source of heat which is excited by friction.' His research in this field was instrumental in discrediting the caloric theory and in stimulating the then new theory of thermodynamics.

It was about this time that Rumford became interested in the project of the Royal Institution and, as already mentioned, it was founded in 1800. Rumford selected Sir Humphrey Davy to be the Institution's scientific lecturer.

Rumford continued to live in London until 1804, when he went to live in France, making a second marriage with the widow of Lavoisier, the celebrated chemist. He died suddenly at Autieu, at the age of 62.

Revival of the East German Chemical Plant Industry

(Specially contributed)

Although in Western countries little information is published on the chemical plant industry of Eastern Germany, this does not mean that the industry is dormant. On the contrary, since the war there has been a great attempt to improve existing equipment and to develop new units. Hitherto, most of this has been needed for re-establishing the domestic chemical industry and to develop chemical industries in East European countries and in China. Nevertheless, some has been exported to the West and now there is considerable interest in selling to Middle East, Latin American and Asian countries. Here is a report of the industry's present status and a description of some of its latest products, which include de-phenolising plants, mixers, roll mills, high-vacuum pumps and welding equipment.

CURRENT plans for the development of the East German engineering industries place heavy emphasis on the production of a wide variety of chemical equipment. The chemical industry plays a key role in the East German economy and, apart from the requirements of the general programme of expansion now in progress, the output of equipment is being increased to serve the country's export trade.

A traditional German export, chemical equipment has in recent years been assuming more and more importance in the Eastern Zone's foreign trade. Plant and equipment, including complete factories, have been supplied to the Soviet Union, China and the countries of eastern Europe for some time and more recently newly developed machines, especially for the plastics and food industries, have gone to such Western countries as Holland and Belgium. It now appears that the East German industry is making a special bid to sell chemical equipment to the under-developed countries in return for raw materials, the deficiency of which is especially marked in the country.

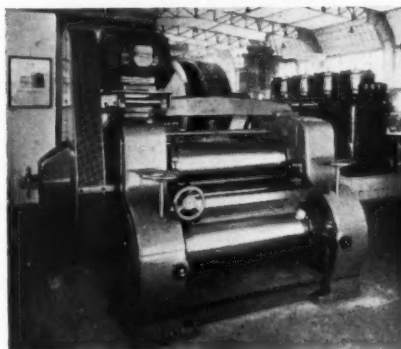
An East Berlin economic journal took up a familiar argument recently when it recalled that, at the Moscow economic conference in 1952, Burmese and Pakistani delegates said their countries wanted plant and equipment for chemical industries and to exploit mineral resources, and declared: 'Almost all these import requirements of Burma and Pakistan can be met by us.' Individual units are known to have gone from Eastern Germany to India, Pakistan and Indonesia, but the present concentration on the production of complete plants clearly reflects the hopes the East Germans have of making these the basis for a large-scale entry into the markets of the under-developed countries.

Plant for export

Many units are already being offered for export. They include plants for the processing and manufacture of alcohols, vegetable, mineral and synthetic oils, car-



Planetary mixing and kneading machine made mainly for export.



Triple-roll mill with pendulum-type bearings.

bon derivatives, soap, urea, plastics, paints and lacquers, photographic film, DDT, salt electrolytes and cane and beet sugar. Large refrigerating plants, artificial skating rinks, air-conditioning plants and wire galvanising and tinning plants are also available. A sugar factory has already gone to the Soviet Union from Eastern Germany

and another is scheduled for delivery to China before the end of this year.

Chemical equipment formed one of the most prominent East German exhibits at the Leipzig Fair last September and British buyers were among the buyers. Delivery times quoted at the fair by representatives of the East German foreign trade organisation were three to six months for individual units, nine to twelve months for complete plants and up to fourteen months for sugar factories. It was explained, however, that the aim was to reduce delivery times still further for Western countries 'because we are interested in expanding trade with them.' Eastern demands have reportedly been keeping the industry fully occupied, but there is a marked interest in increasing exports to Western, Middle East and Asian and Latin American countries.

In addition to the Soviet Union, the East European countries, all of which are expanding chemical production on a big scale, have provided large markets for products of the East German industry. A recent development has been an East German-Rumanian agreement under which the two countries are to form a joint concern to enlarge the Rumanian chemical industry. The East Germans are to supply equipment and the Rumanians raw materials.

China, however, is the country that offers markets which have been described as virtually limitless. At a press conference held during the Leipzig Fair one East German spokesman said that if the East German industry had the capacity, 'orders from China alone would keep it busy for three generations.' Indications are that the recently announced first five-year plan for the industrialisation of China will result in even greater exchanges between China and Eastern Germany than the considerable ones that are already taking place. The sugar plant now being made for the Chinese, for example, is likely to be followed by further orders, since China's long-term aim is undoubtedly to achieve self-sufficiency in sugar production. Before

the war, Germany supplied sugar factories to the whole world from three large works at Bukerwolf, Sangerhausen and Halle. Manufacturers of heavy chemical equipment are also known to be prominent among the many industrialists sponsoring a recently formed 'East Committee' which is to foster Sino-German trade.

De-phenolisation plant

Some of the latest products of East German plants give an indication of the present position of the industry and its plans for the future. One of the most interesting is a de-phenolising plant based on a new process developed by Dr. Alfred Dierichs, of Pirna, near Dresden. In this plant phenol is dissolved by the usual selective solvent and extracted on the counter-current system. A seven-stage continuous process takes the place of the former three stages and is said to have reduced the final percentage of phenol from 120 to 150 mg./litre to a maximum of 50 mg./l. The makers claim, however, that experimental results have shown that the final concentration can be reduced to 20 mg./l. The process is being used at Lauchhammer where a coking plant producing metallurgical coke from brown coal is scheduled to reach an output of 1,300,000 tons p.a. Phenol, needed especially for the Eastern Zone's considerable plastics industry, is currently engaging large teams of chemists and research workers in Eastern Germany. Experiments in hand are for the recovery of phenol from generator gases, as in steel works, and from sewage water. Hungary is also now making coke from brown coal and a de-phenolising plant is being supplied by Eastern Germany.

Mixers and roll mills

Some improvements in design are noticeable in the latest East German planetary mixing and kneading machine. A 55-gal. pre-mixer for dyestuffs, cosmetics and plastics has a hydraulically lifting agitator and the mixing tank mounted on wheels. Agitators have been designed to ensure thorough mixing and facilitate cleaning. The machine has high and low speeds and power required is 5.5 kw. The length of the machine is 5 ft., the width 3 ft. and the height 7 ft. 6 in. Net weight is just under 1 ton. It is made largely for export by Nagema, a nationalised chemical factory in Heidenau. Machines have been supplied to Holland.

A triple-roll mill for the preparation of plastics, paint and printing inks, features pendulum-type bearings with gears running in a fully-enclosed oil bath. The electric motor is mounted on top of the frame to reduce floor space and a smooth outer finish facilitates cleaning. Three models are being made at Heidenau, the largest, weighing 4.5 tons, having an output of 330 to 660 lb./hr. A five-cylinder roll mill for chocolate is of similar construction.

A new automatic drum-type chrome-plating machine is for small nickel-plated



Single, twin and quadruple two-stage vacuum oil airpumps for the electric lamp industry

parts. Plating time is four to five min. and the entire process from the time parts are poured into the funnel until they drop into the delivery tray is 5½ min. Capacity of the machine is 20 to 55 lb./hr. of small parts—nipples, washers, nuts, etc.

Pumps and compressors

Chemical pumps and compressors are important products of the East German industry, especially for the export trade, and production under the current five-year plan (1951-55) is scheduled to more than double. New *Simplex* pumps have capacities of 5 and 10 cu.m./hr. Maximum vacuum is 3×10^{-6} mm. Hg. Two-stage, high-vacuum oil airpumps as single, twin and quadruple pumps are also being made for the electric bulb industry. Four-stage diffusion pumps (300 to 1,500 c.m.h. at 10^{-4} mm. Hg) are being produced for high-vacuum coating plants, metal distillation and freeze-drying. Exports are in the main going to Eastern Europe.

East German welding equipment includes new butt-welding machines capable of welding bodies with a cross-section from 20,000 to 40,000 sq. m. Staggered spot welding has been developed as a new process and other recent products include a new spot and seam welding machine up to 60 kva. and new mobile welding transformers and power units.

Porcelain plants

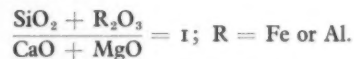
Another development in the East German industry that has a bearing on the country's export trade has been the use of Thuringian porcelain for HCl rectifying plants and plants making penicillin. The shortage in Eastern Germany of high-grade alloy steels led to the experiment with porcelain, but it is now regarded not as a substitute but as a new material likely to have increasing importance in the chemical industry. Results have proved satisfactory and output is said to remain the same for a lower manufacturing cost. Porcelain is also reported to have proved suitable for

sulphuric acid plants and others handling highly reactive substances. Other porcelain equipment in use in Eastern Germany includes boilers and agitators, stills and cooling towers.

Mineral wool from sugar factory waste

Mineral wool, a useful heat and sound insulating material, can be made from the filter press mud from sugar refineries by a process developed at the Shri Ram Institute for Industrial Research, Delhi. About 6,000 tons annually of this mud is available from India's 134 sugar factories. Although some is used as a fertiliser, most of it was simply a troublesome waste until this process was evolved.

In the process, described in the *Journal of Scientific and Industrial Research* (1952, 11 (9), 412-413), filter press mud and sand is mixed together in a mechanical mixer in the ratio of



Soda ash, alumina, wood ash, borax, bauxite, alum and ammonium phosphate is used as a flux either separately or mixed. The mixture is placed in a furnace and the temperature of the charge raised to 1,000 to 1,600°C. and the heating continued until the mass attains the proper viscosity. It is then tapped in a thin stream from the side of the furnace. This stream is atomised into tiny globules by a jet of steam played on it at 1,000 ft./min. and at a pressure of 70 to 200 p.s.i. These globules are then directed into a long tunnel where they shape themselves into long fibres. The fibre is then sprayed with a binding material, e.g. synthetic resin, pressed into felts and baked ready for use.

The estimated cost of production for a full-scale plant producing 4 tons of mineral wool per 8-hr. day is Rs. 207.8 per ton of wool.

CHEMICAL ENGINEERING PROGRESS IN THE UNITED STATES

By Francis J. Curtis, B.A.

At the annual dinner of the Chemical Engineering Group of the Society of Chemical Industry held in London on April 10, Mr. Curtis, president of the Society, was chief guest. He responded to this honour by giving an unusually interesting and penetrating survey of the contemporary American chemical engineering scene. Mr. Curtis's position as a vice-president and director of the Monsanto Chemical Co. of St. Louis, U.S.A., and past-president of the American Institute of Chemical Engineers, lends particular authority to his observations. Here is an abbreviated version of his speech.

BEFORE I get started on the main subject, I would like to say a little about the American Institute of Chemical Engineers, with which I have been closely associated for about 15 years. The American Institute occupies a position somewhat intermediate between the Institution of Chemical Engineers in Great Britain and the Society of Chemical Engineers in the U.S.A. It had a membership in 1952 of 12,600, divided into four classes: 4,800 active members, who must have carried out important chemical engineering work under conditions of responsible charge for a period which varies with their degree of education; 600 associates, who nowadays can be almost anyone with an active interest in the profession; and 7,200 juniors, who as the name implies are the younger men just out of school and under 35 years of age. We also have a student grade which has just been started and which now has about 1,100 members.

One of the most important accomplishments of the American Institute has been the accrediting system for universities and colleges.

During the past decade, chemical engineers have developed new techniques for carrying out reactions. They have perfected several techniques for separating and purifying both raw materials and finished chemicals. Finally, they have taken advantage of a change in the economics of large-scale production to construct and operate 'tonnage' ethylene and tonnage oxygen plants.

Nitric oxide production

As an example of a new reaction technique, nitrogen and oxygen from air may be converted directly to nitric oxide (NO) by heating air to an extremely high temperature. The device developed for reaching the high temperature is known as a pebble heater. In this heater, a bed of special refractory pebbles is heated with natural gas and air and moved into another zone, usually by gravity. Preheated air is passed over the hot pebbles to raise its temperature to a maximum of 4,000°F.

The process is known as the Daniels process. The nitric oxide may be subsequently oxidised and converted to nitric acid. This development gives a thermal

method for converting nitrogen in air to fixed nitrogen, ultimately for fertiliser, without passing through ammonia as an intermediate. It offers a possible alternate method for carrying out oxidation reactions by utilising nitric oxide and oxygen in place of the usual nitric acid.

Fluidisation

Several decades ago, Winkler developed a fluidised reactor for generating gas from coke. His development was modified and extended during the late 1930s in the United States to the catalytic cracking of petroleum. Before fluidisation became a commercial success in the United States, many engineering problems had to be solved. Among these were those of reducing erosion and attrition of the solids, transporting and conveying the solid catalyst from one vessel to another and, finally, the recovery of microscopic catalyst particles. Perhaps the great advantage of fluidisation lies in close temperature control, estimated to be within about 25°F. for reactions involving removal or addition of heat. In addition, it particularly lends itself to catalyst regeneration.

As yet, chemical engineers have not made rapid progress in applying fluidisation to reactions other than petroleum refining. However, within the past few years, they have slowly but surely applied fluidisation to the calcination of limestone, the hydrogenation of carbon monoxide for synthetic fuels, the oxidation of naphthalene to phthalic anhydride and the catalytic oxidation of ethylene oxide, etc.

Natural gas and petroleum

At least two plants in the U.S. are extracting from natural gas transmission lines a C₂-C₅ hydrocarbon mixture. The C₂ fraction, mostly ethane, is used as a raw material for ethylene. The propane-butane fraction is sold as liquefied petroleum gas. The pentanes and heavier are blended as natural gasoline. Although this development is essentially one of engineering economy, it permits the construction and operation of plants based on ethylene and propylene at locations far removed from their source in the natural gas fields. Provided there is a demand for C₃s and heavier, this operation gives

relatively low cost ethane as charge stock for an ethylene plant.

By 1949, the U.S. demand for chemical benzene from coal tar sources far exceeded the supply. Consequently, an additional source of benzene was necessary for continued growth of chemicals derived from benzene. In the U.S. the petroleum industry came to the rescue. The production figures are as follows:

		From coal tar (Million U.S. gal.)	From petroleum (U.S. gal.)
1950	..	155	—
1952	..	190	45
1955 (est.)	..	235	145

However, the price of benzene from coal tar has risen from 15 cents per U.S. gal. in 1946 to 30 cents in 1952 and has just gone up another 6 cents. Prices of benzene produced from petroleum have fluctuated rather widely between 40 and 60 cents per gal. It would be my guess that it will settle around 40 to 45 cents. Petroleum refiners produce aromatics by catalytically reforming a naphtha fraction. This reforming consists of passing a naphtha fraction over a platinum or molybdenum catalyst at 900 to 1,000°F. and under 200 to 1,000 p.s.i., with a large amount of hydrogen present. The naphthenic hydrocarbons such as cyclohexane and methyl cyclopentane are thereby isomerised and dehydrogenated to benzene. The gaseous effluent from the reactor is cooled, condensed and subsequently purified, as discussed below.

Practically speaking, the quantity of methyl derivatives of naphthenes in petroleum fractions is several-fold that of single-ring C₆ naphthenes. While the C₆ naphthenes are the charge stock for benzene, the C₇s are for toluene and the C₈s for the xylenes. Roughly, the ratio of C₆:C₇:C₈ naphthenes is about 1:4:10 (this ratio is just about reversed for the corresponding aromatics in by-product coal tar). Consequently, large quantities of toluene and xylenes may be produced by catalytically reforming a naphtha or gasoline fraction. Thus petroleum refiners are in a favourable position to produce large quantities of either toluene or xylenes for the chemical industry.

As a potential raw material for chemical manufacturing the xylenes appear quite attractive. For example, *ortho* xylene is a suitable raw material for oxidation to phthalic anhydride. *Para* xylene is being oxidised to isophthalic acid for use in plasticisers.

Because the xylene isomers boil quite closely together, they are usually separated by a 'super fractionation' to remove the *ortho*, followed by low-temperature ($-95^{\circ}\text{F}.$) crystallisation to separate the *meta* and *para*. In the U.S., at least two plants are now separating *para* xylene for use as a chemical raw material, primarily for terephthalic acid.

Separation processes

Several techniques for separating chemical compounds have been developed and commercialised during the past decade. Among these may be mentioned hypersorption, gaseous diffusion, azeotropic and extractive distillation, and finally extractive crystallisation.

When benzene is produced from petroleum, the reformer effluent contains benzene, cyclohexane and paraffins. Not only do these compounds boil closely together, but also they form both binary and ternary azeotropes (constant boiling mixtures). Since the chemical industry requires a benzene of nitration grade, the benzene must be purified into specification grade material. For this purification three techniques are commonly employed.

The first is solvent extraction, in which either liquid sulphur dioxide or such a solvent as ethylene glycol is used to separate the aromatics from the naphthenes and paraffins. By several contractings and suitable recycling, an extract high in aromatics is produced. Such an extract is then fractionated to obtain specification grade benzene.

Another technique is to fractionate the effluent from the reforming unit in the presence of a phenol solution. The phenol is added near the top of a fractionating column, flows down through the column and passes out with the bottoms. This technique is known as extractive distillation. Originally it was developed and used by the Shell Oil Co. for purifying toluene from petroleum for nitration to TNT.

Still another technique has been developed using an activated silica gel to separate aromatics from naphthenes and paraffins. Essentially, the silica gel replaces the solvent in solvent extraction. The process, *Arosorb*, was developed by Sun Oil.

For many years azeotropic distillation was used to dehydrate ethyl alcohol from its constant boiling mixture with water. Benzene was commonly used as the azeotropic agent.

New separation techniques have been developed for purifying butadiene, which is obtained in increasingly large quantities from petroleum sources.

As one example, ammonia is used to recover butadiene commercially from its mixture with butanes and butylenes. Ammonia forms an azeotrope with butadiene, thus allowing a relatively simple separation. The ammonia from this azeotropic mixture may be recovered by stripping and by water absorption. Dow built and operated the first butadiene plant in the U.S. to use azeotropic recovery of butadiene with ammonia.

As another example, butadiene may be recovered by adding furfural to operate the separation as an extractive distillation. When furfural is added either to the butane-butylene mixture or to the butylene-butadiene mixture, the relative volatilities are changed in such a way that butylene and butadiene may be recovered. The dehydrogenated mixture may be pre-fractionated and then subjected to extractive distillation so that the butadiene may be separated and purified to specification material.

More recently a separation technique known as extractive crystallisation is finding commercial application. In this, urea is added to a mixture in which it forms an 'adduct.' The adduct may be removed by crystallisation, the crystals decomposed, and the urea returned to be recycled to the process. Developments are under way to use this extractive crystallisation for separating chemical isomers and for refining petroleum mixtures for both lubricating oils and jet fuels.

Probably the most difficult separation problem known is that for the uranium isotopes. To separate U_{235} from U_{238} , both the centrifugal and gaseous diffusion methods were developed and operated.

Because of the slight difference in isotope masses, something like 22,000 separately driven centrifuges, operating at extremely high speeds, were required. Because of the slight difference in rates of diffusion, something like 5,000 porous diffusion barriers were necessary. Before the uranium isotopes could be separated by gaseous diffusion, they had to be converted to a gaseous compound, namely the hexafluoride.

These techniques for purifying the uranium isotopes are expensive, both for capital and manufacturing cost.

For several years gas chemists used activated carbon to separate hydrocarbon gases by chromatographic analysis. During the past decade, chemical engineers of the Union Oil Co. have translated this technique to a commercial scale. They refer to the process as hypersorption and solve the problem of cyclical operation by continually moving the bed of activated carbon.

Hypersorption is used for separating light hydrocarbons, especially in dilute gas mixtures. The Dow Chemical Co. uses hypersorption to purify ethylene at their Midland plant.

Several developments are the result of producing raw materials in large quantities

such that the economics become attractive.

One example is the recent plant of Gulf Oil at Port Arthur, Texas, for producing ethylene. The capacity of Gulf's plant is reported to be 2.5 billion cu. ft. of ethylene gas per year. This quantity of ethylene is such that no one chemical company would be likely to build such a large plant and thereby achieve the low production cost. Consequently, Gulf is transporting ethylene gas by a 100-mile pipeline to five chemical companies in their vicinity.

Another example is the recovery of oxygen from atmospheric air in quantities corresponding to 500 tons/day and larger. Such tonnage oxygen plants are producing oxygen to reform natural gas to carbon monoxide and hydrogen for subsequent Fischer-Tropsch synthesis to liquid fuels and by-product chemicals. Another plant is used to produce oxygen for converting natural gas to acetylene by the Sachsse process. This large-scale production of acetylene in the U.S. may alter the economics sufficiently so as to make the entire field of Reppe acetylene chemistry competitive with ethylene chemistry. Still another example is the application of tonnage oxygen to reduce iron oxide in a blast furnace, particularly to reduce the consumption of metallurgical coke.

The future

In 1955, goals of the Defense Production Administration show a 55% over-all increase in chemical capacity. These goals are being achieved by permitting fast amortisation to some degree or another and many people have wondered whether we will be able to utilise this capacity. The only way we can determine this is to look at the past. It is an interesting thing that when you plot on semi-log paper the growth of the chemical industry in production from 1915 to 1951 you come out with practically a straight line. The compounding average rate of growth is 9% per year since 1929. If this rate, therefore, holds for four years more, we shall have grown 36%, which means that we would catch up with our capacity by 1957, barring a major war. Of course, if we get into a war, all bets are off and we will need much more capacity than we now have. It does not seem, therefore, that there is any tremendous risk of excess plant hanging over our heads.

This expansion has had a number of effects, and one of the most important has been the enhancement of the importance of the chemical engineer. He has gone out of the design groups into research, construction, operation, sales and top management. In fact, there does not seem to be any avenue closed to him.

There is, therefore, a great opportunity and a great responsibility in Great Britain on groups such as yours, and I hope in the years to come the Chemical Engineering Group of the S.C.I. will be credited with a great share in the coming expansion of the British chemical industry.

Safe Disposal of Contaminated Air from Radiochemical Laboratories

By J. W. J. Fay, Ph.D., D.I.C.

(A.E.R.E., Harwell)

In radiochemical laboratories, an important problem arises from the need to dispose safely of the air exhausted from glove boxes and fume cupboards in which radioactive materials are handled. In this authoritative article, the author discusses the hazards involved and explains how they can be eliminated most economically. The article is of exceptional interest because hitherto users of radioactive materials have had relatively little published information to guide them in meeting the hazards of contaminated air.

ONE of the major considerations in the construction of laboratories in which considerable amounts of open radioactive sources are to be used is the safe disposal of the exhaust air from glove-boxes and fume cupboards.* Apart from compliance with any regulations which may be issued under the Radioactive Substances Act, it is obviously desirable that the release of contaminated air into the outside atmosphere should be so controlled that two requirements are met:

- (1) No person should be continuously exposed to aerosol concentrations exceeding or even approaching those laid down as the maximum permissible breathing levels.
- (2) The deposition of radioactive dusts should not occur in such a way that health is endangered or experimental and counting work affected.

However carefully operations with open sources are conducted within the ventilated enclosures, some of the active material is almost certain to become airborne from spills, evaporation of solutions, splashing during transfer, drying out of spots of contamination and so on. It is impossible to generalise about what proportion of the total activity handled becomes airborne, but in typical operations by experienced radiochemists at Harwell it has been shown that it can be as little as 1 to 10 p.p.m. If the proportion can be estimated with reasonable accuracy for the particular operation involved, or can be measured by some form of accounting system, it is possible to assess the hazards and hence to plan how they can be most economically eliminated.

The released activity may be particulate or gaseous or both, and if particles are present their mass will have a great influence on the extent of the hazard. This is not because the actual size of the particles has any especial bearing on their relative toxicity—the International Commission on Radiological Protection¹ did not feel called upon to make any observations or recom-

mendations on this point—but because heavy particles will obviously tend to fall close to the outlet and give rise to high concentrations in terms of mass per unit volume of air near the ground, rather than to be carried away in the wind and effectively diluted. It is therefore useful to consider the influence of particle size on settling rate as far as it affects the possible contamination of the neighbourhood. Apart from the settling of particles, however, the dissemination of gaseous, *i.e.* non-settling, activity will constitute a potential breathing hazard which has to be assessed, so that these two aspects will be examined separately and the final conclusions drawn from a consideration of both.

The deductions to cover the breathing hazard are comparatively easy, but it is more difficult to be specific about the contamination problem. For different circumstances, such factors as the prevailing meteorological conditions, the nature and particle size—and hence rate of settling—of the disseminated activity and the degree of control required will vary so much that each case will have to be considered on its merits by the individual user. It is, however, possible to give some guidance on the way in which it can be done.

Although scrubbers are sometimes employed in special cases, the two main methods of controlling the emission of activity are the use of an efficient stack or similar outlet and the incorporation of filters in the exhaust system. Both methods are expensive, but the use of filters has two comparative disadvantages. More powerful fans are usually required, since

not only has the resistance of the output filters to be overcome but input filters are desirable to remove atmospheric dust which would otherwise clog the 'active' filters. In addition, maintenance costs have to be met in replacing the filters periodically. The finer the filters, the greater these additional costs become, and often a combination of the two methods will be the best solution, *i.e.* a coarse filter to remove large particles and a stack to give adequate dilution of the residual activity. Filter requirements are capable of straightforward calculation, but the dilution effects from stacks are less well known and it is worth examining in some detail their application to this problem.

Particle settling

Although there is some experimental evidence that atmospheric turbulence has an appreciable effect on the rate of diffusion and deposition of very small particles,² it will be sufficiently accurate for the present purpose to assume that the settling rates of the more massive particles are determined by their terminal velocities under gravity in free air, as calculated from Stokes's Law. From these settling rates, one can deduce the times required for particles of different sizes and specific gravities to fall from a given height and hence the distances which they might be expected to travel before deposition in specified conditions of wind velocity.

Applying this treatment to a 25-m. stack, such as might be used as a central disposal system in an establishment handling radioactive materials in quantity, the typical figures given in Table I are obtained:

Table I

Particle diameter (μ)	S.G.	Settling rate in free air (cm./sec.)	Time to fall from 25 m. in free air (sec.)	Distance carried (metres) in wind velocity	
				1 m./sec.	5 m./sec.
10	1	0.3	8,200	*	*
10	10	3	800	800	*
20	1	1.2	2,000	*	*
20	10	12	200	200	1,000
30	1	2.7	900	900	*
30	10	27	90	90	450
60	1	11	230	230	1,150
60	10	110	23	23	115

*In these conditions the particles would be subject to appreciable eddy effects and the figures calculated from Stokes's Law are not valid.

*The design of radiochemical laboratories was reviewed by the author in *CHEMICAL & PROCESS ENGINEERING*, September 1952, pp. 498-500.

Filtration systems

When the potential hazard for any given circumstances has been assessed and it has been decided that some form of filtration system is required, the question arises as to what form this should take. With glove-boxes the problem is simple. Thus, if a total of 100 millicuries is manipulated in the box, and as much as 0.1%, i.e. 0.1 mc., becomes airborne per day, a filter which is efficient to 1 part in a thousand will pass only 0.1 μ c. in that time; later it will be seen that this is normally adequate.

In the case of fume-cupboard exhausts, the methods which have been used to remove dangerous amounts of radioactive dusts vary from an elaborate centralised electrostatic precipitator, filtering the common stack exhaust from several laboratories, to simple cloth, fibre, glass-wool or resin-wool filters fitted to individual fume cupboards. The individual filter is often preferable for three reasons. First, the filter can be chosen to be of the simplest type consistent with the requirement. Secondly, the tendency for air-ducts to become contaminated is reduced. Thirdly, the filter is comparatively easily cleaned or replaced when necessary. The actual type of filter used will depend upon the circumstances and the selection must be based upon such considerations as resistance, throughput, size of particles to be removed and efficiency required. In many cases, a simple glass-wool filter will be adequate to guard against continuous emission of small amounts as well as occasional 'bursts' of larger quantities of radioactive particulates when accidents occur.

Normal breathing hazards

When steps have been taken to remove dangerous amounts of heavy particles, the question still remains as to what quantities of gaseous or non-settling activity may safely be released without producing a breathing hazard. The problem arises not only in the large establishment with an efficient stack, but also in the orthodox laboratory without such facilities. It is therefore important to consider what hazard is involved from any evenly disseminated activity which passes through the filters. In the examples which follow, it should be noted that the figures deduced refer to the most hazardous isotopes of each type, and corresponding relaxations may be permitted with less dangerous materials.

Dilution from stacks

The distribution of airborne pollution in the form of particles sufficiently small to remain indefinitely in suspension has been considered mathematically by Sutton.³ His treatment is largely a theoretical one for the ideal case where the air-flow is undisturbed by neighbouring buildings or other obstacles, and in practice it may be advisable to check the absence of appreciable eddy-currents by some means, such as smoke-dissemination experiments. With

this proviso, Sutton's data can be used to deduce what he calls 'average risk' figures for the rates of steady stack emission which should be allowable without subjecting exposed personnel to a breathing hazard. Suppose, for example, it is specified that the concentration of activity at points where the air is likely to be breathed should not exceed the currently-accepted maximum permissible levels (M.P.L.) for occupational workers.¹

Then, on a flat, open site with a tall stack and no interfering buildings, the amounts, in round figures, of 'non-settling' plutonium-239 and strontium-90, the most hazardous α - and β -emitters respectively, which may be released in average conditions into a 1 m./sec. wind evenly over a period of 24 hr., without the M.P.L. being exceeded at ground level down-wind, vary with stack height as shown in Table 2.

Table 2

Height of stack (metres)	Maximum steady daily emission (mc.)	
	Pu ²³⁹	Sr ⁹⁰
10	0.1	10
25	0.5	50
50	2.0	200

It is worth noting that Sutton's deductions indicate that in this case the point of maximum concentration at ground level occurs at a distance down-wind equal to about 20 times the height of the stack in average conditions, i.e. no large lapse or inversion, but the stability of the atmosphere has a marked effect on this distance as well as on the actual concentration.

Few sites are able to attain the dilution effects possible with an ideal stack and, in most cases, there will be neighbouring buildings of comparable height to the stack. Provided the nearest building down-wind is at least 50 m. away, however, a considerable dilution can be relied upon in the horizontal plane. Sutton's data enable estimates to be made of the maximum amounts of non-settling activity which may in these circumstances be disseminated in average conditions evenly over 24 hr. into a 1 m./sec. wind, so that the M.P.L. should not be exceeded at a point of the same height as the stack outlet. The manner in which these estimated permissible releases vary with proximity of the nearest such building down-wind, for distances of 50 m. and more, is given in round figures in Table 3.

Table 3

Distance down-wind (metres)	Maximum steady daily emission (mc.)	
	Pu ²³⁹	Sr ⁹⁰
50	0.005	0.5
100	0.02	2
200	0.07	7

These quantities are well below those for even a moderate stack, and it is emphasised that a relatively small effective

stack-height gives an appreciable advantage in reducing the concentration.

As already pointed out, these figures refer to the maximum permissible exposures of occupational workers, i.e. the small proportion of the population which is subject to regular medical examination in the course of its employment. For large bodies of non-occupational workers, such as the population of a big city, it might be desirable to apply a safety factor, and at first sight this might seem to restrict still further the amounts of activity which could be released. On the other hand, two pessimistic factors have been incorporated in the calculations. First, no allowance has been made for 'swing of the wind,' and from experimental evidence it seems reasonable to allow a factor of 20 for this. Secondly, the velocity of the wind has been taken as 1 m./sec., and if a more usual figure of 5 m./sec. (11 m.p.h.) is assumed, this provides another factor of 5. Together, therefore, these two considerations represent a factor of 100, which should be sufficient to balance out any reduction which has to be applied to the permissible breathing concentrations to cover non-occupational workers.

Orthodox laboratories

Most laboratories will be so situated that the lack of effective height of the effluent outlet point and the presence of nearby buildings mean that the above considerations cannot be applied. For example, in an orthodox laboratory, the fume-cupboard exhaust is often taken through the wall or ceiling in the immediate vicinity of a window. Here it may be necessary to assume that an appreciable proportion of the disseminated activity re-enters the laboratory or enters a neighbouring building. If the volume of such a laboratory is 2,000 cu. ft., and a linear air velocity of 100 ft./min. is maintained across a fume-cupboard opening of 2 sq. ft., this involves six air-changes per hour. Hence it can be calculated that the maximum amounts of activity which may be allowed to enter the occupied area evenly over a period of 24 hr., if the breathing concentration is not to exceed the M.P.L. for occupational workers, are:

$$\begin{array}{ll} \text{Pu}^{239} \dots\dots\dots & 0.02\mu\text{c.} \\ \text{Sr}^{90} \dots\dots\dots & 2\mu\text{c.} \end{array}$$

In this particular case, the figures will probably be applicable whether the released activity is particulate or gaseous, since one of the assumptions is that some of the air re-enters the laboratory immediately after release, i.e. before particles have had time to settle. The hazard from disturbance within the laboratory of accumulated settled particles is, of course, covered by regular monitoring and cleaning of the surfaces.

In order to present some sort of general picture of the problem to be faced in a laboratory of this type, it is of interest to tabulate the requirements for specified ranges of operations and conditions, start-

ing with certain assumptions and indicating where one must look for the factors which either decrease or increase the potential hazards, and hence the precautions required, in circumstances different from those in the example taken. Suppose one considers this orthodox laboratory, using Sr^{90} in a fume cupboard, and specifies that the maximum permissible breathing concentration for occupational workers must not be exceeded in the laboratory. On the assumption that as much as 0.1% of the total activity handled in the fume cupboard is steadily emitted as an aerosol every 24 hr., the requirements may be summarised as in Table 4.

Factors which have to be considered for different conditions from those specified are:

- (1) The potential hazard is increased by a factor:
 - (a) of 100 for the more hazardous α -emitters;
 - (b) corresponding to the number of fume cupboards or laboratories.
- (2) The potential hazard is decreased by a factor of 100 or more for the less hazardous isotopes.
- (3) An appropriate factor must be applied if the steady loss-rate is different from that assumed.

Contamination background

As stated before, the question of deposition of activity will have to be assessed individually in each case, but as a guide it is useful to consider the possibility of increasing the natural background—approximately 10^{-6} röntgen/hr.—in the neighbourhood. It is worth noting in this connection that the deposition of about 1 $\mu\text{C}/\text{sq.m.}$ of γ -activity is sufficient roughly to double this background. In practice, an increase of this magnitude is unlikely to affect counting work, normally carried out in lead castles, and it could be argued that the limiting factor in deposition is really the external radiation hazard. If this is permitted to reach 0.05 r./wk., i.e. one-tenth of the M.P.L. for occupational workers,¹ the limiting deposition will be 30 $\mu\text{C}/\text{m}^2$.

It follows that to double the background over an area of 1,000 sq. m. the total deposition of a γ -active isotope would have to be 1 mc., and in order to produce a radiation level of 0.05 r./wk., 30 mc. would have to be deposited in this area. In normal circumstances, therefore, an orthodox laboratory handling $\beta\gamma$ -activity in such a way that the breathing requirements for Sr^{90} are met, i.e. emitting less than 2 $\mu\text{C}/\text{day}$, is not likely to be troubled by increased background, even if a large proportion of the disseminated activity is deposited in the neighbourhood.

In the case of a large establishment covering an area of, say, 1,000 m. \times 1,000 m., and releasing activity from a 25-m. stack, it has been shown that the limiting conditions for deposition on the site in a

Table 4. Requirements for a single orthodox laboratory handling Sr^{90} such that the maximum permissible breathing concentration is not exceeded as the result of re-entry of exhaust air

Activity level	Assumed continuous, steady daily loss		Permissible daily intake of Sr^{90} in the laboratory air (μC)	Reduction factor required
	%	Activity (μC)		
10 μC .	0.1	0.01	2	—
1 mc.	0.1	1	2	—
100 mc.	0.1	100	2	50

1 m./sec. wind are roughly 30 μ particles of unit density and 10 μ particles of density 10. In a 5 m./sec. wind, the limiting particle sizes are 60 μ (density 1) and 20 μ (density 10). In many cases, therefore, a filter which retains particles down to 20 μ diam. will be sufficient to prevent a deposition hazard, but it may be necessary for 10 μ particles to be removed. Suppose, for example, we take the borderline case, where the particles are sufficiently small not to constitute a breathing hazard by falling out in a concentrated cloud near the stack, but are just large enough to be deposited on the site. To increase the background to 0.05 r./wk., neglecting washing away by rain, etc., roughly 30 curies of a long-lived γ -emitter would need to be uniformly spread over the site. If it is assumed that this should not occur in less than 10 years, this corresponds to the evolution of 8 mc./day. This is a factor 6 below what could be allowed for Sr^{90} from purely breathing considerations, i.e. 50 mc./day, and would, of course, be even more below the corresponding permissible releases for $\beta\gamma$ -isotopes that were less hazardous than Sr^{90} . Hence the need to provide filters of suitable efficiency is apparent.

It should, perhaps, be mentioned that a radiation level of 10^{-6} r./hr. is produced at a height of 1 m. from a flat surface on which about 0.1 $\mu\text{C}/\text{m}^2$ of a 1 MEV β -emitter has been deposited. This is one-tenth of the concentration required in the case of a 'pure' γ -emitter, but the danger of increasing the general background radiation is much less because of the relatively short path of the β -rays in air and the high degree of absorption after the particles have 'weathered' following deposition on any rough surface such as earth or grassland.

Accidental release of activity

In the examples given, it has been assumed that the release of activity occurs evenly over the 24-hr. period and not in bursts such as might arise from an accident, and it is of interest to consider the possible health hazard from such an accident in the typical cases which have been quoted. It is worth noting that in such an event the particle size is likely to be fairly large, and hence a crude filter would remove the bulk.

In the case of an accident in our typical orthodox laboratory involving the sudden release of 1 mc. in a fume cupboard with no filter, and assuming that as much as 10% of the extract air re-enters the laboratory, the maximum concentration reached would be 0.1 mc./2,000 cu. ft., or 1.8 $\mu\text{C}/\text{m}^3$. This would obtain for 10 min., in which time an occupant, if he did not leave the laboratory or put on a respirator, would inhale about one-sixth of a cubic metre of air containing a total of 0.3 μC . If the activity consisted entirely of Sr^{90} , one-sixteenth of the inhaled activity would be retained in the body, and this would leave him with a body burden of 0.02 μC , compared with the maximum permissible figure for occupational workers¹ of 1 μC . At the 100-mc. level, with the recommended minimum reduction factor of 50, the sudden release of the whole 100 mc. would result in a comparable hazard of 20 times this magnitude.

For a laboratory or establishment with a reasonable stack, the corresponding hazard would be less. Assuming that 100 mc. were released as a non-settling cloud from a 10-m. stack over a period of 1 min., and that the wind velocity was 1 m./sec. in average conditions, then the maximum concentration at ground level³ would be 2.2 $\mu\text{C}/\text{m}^3$. In 1 min. an exposed person would breathe about one-sixtieth of a cubic metre of contaminated air, and would therefore inhale 0.04 μC . With Sr^{90} this would produce a body burden of 0.003 μC . A similar calculation for the same accident happening in a building with no effective stack height shows that a person standing 50 yd. down-wind would retain about 0.05 μC of Sr^{90} in the body. A corresponding reduction in the hazard would, of course, result in each case if the wind velocity were greater than the value assumed of 1 m./sec.

Deposited activity

It is worth examining briefly the possible risk from dust raised by wind when the limiting conditions of deposition have been reached, i.e. a radiation level of 0.05 r./wk., corresponding to the uniform deposition of 30 curies of γ -activity over an area of 1,000 m. \times 1,000 m. After weathering, the active particles will have tended to become attached to large, inactive dust particles, and hence the proportion likely to become airborne will be small. Suppose, however, it were possible for the whole of the deposited activity to be suddenly stirred up by a high wind. If the active particles were sufficiently small to become airborne, it is reasonable to suppose that they would be raised to a considerable height by the wind, but for the sake of example let us assume that the dust cloud moved as a blanket over the area and that the activity was uniformly spread to a height of only 10 m. The concentration in the cloud would then be 3 $\mu\text{C}/\text{m}^3$. If the wind velocity were as low as 10 m./sec., the maximum time taken for the cloud to

move past an exposed person would be approximately 2 min. In this time, he would inhale one-thirtieth of a cubic metre of air, containing 0.1 μ c. The hazard arising from this would naturally depend upon the isotope, but it would not be serious as an isolated event with any of the common γ -emitters. Even if it were all due to Sr^{90} , the resulting body burden would be only 0.006 μ c., 0.6% of the M.P.L.

If we consider the worst possible case in which the γ -activity was due to radium-226, the maximum release from a 25-m. stack would be limited on 'breathing' grounds for this isotope, which is one of the most hazardous α -emitters, to 2 mc./day of small particle size. It would therefore take a minimum of 40 years to produce a background of 0.05 r./wk., even if all the activity were deposited on the site and none were washed away. Assuming, however, that this condition were reached, the sudden stirring up of the activity under the pessimistic conditions assumed above would result in the exposed person acquiring a body burden of radium of 0.006 μ c., which is 6% of the maximum permissible figure.¹

Conclusions

From these estimates, it may be concluded that mc. quantities of the common $\beta\gamma$ -isotopes may be handled with care inside fume cupboards in orthodox laboratories without any hazard arising. At the 100-mc. level, a discharge point clear of windows and any other air inlets is

adequate to guard against the small proportion of the activity which becomes airborne in normal operations. A crude safety filter, e.g. of the glass-wool type, which is satisfactory for, say, particles of 20 μ and upwards may, however, be desirable to cope with emergency emission of particulates in the event of an accident, such as a fire, where this is likely to generate an aerosol containing more than μ c. amounts of hazardous $\beta\gamma$ -emitters.

On a large establishment with an efficient stack, a filter which removes particles down to 10 μ diam. will normally be sufficient to prevent any deposition hazard, and the dominant factor is then the regulation of release of non-settling activity so as not to give rise to a breathing hazard, e.g. emission of not more than 50 mc./day of Sr^{90} , or the equivalent, from a 25-m. stack.

Such calculations as these are intended purely for guidance in assessing the magnitudes of the hazards which may be encountered, however, and the object should always be to release as little as possible of radioactive materials into the atmosphere.

Acknowledgment. *The author thanks the Director of the A.E.R.E. for permission to publish this paper.*

REFERENCES

- ¹ International Commission: International Recommendations on Radiological Protection, *Atoms*, 2, 119, 1951.
- ² See, e.g. P. H. Gregory, *Trans. Brit. Mycological Soc.*, 1945, 28, 26.
- ³ O. G. Sutton, *Quart. J. Roy. Met. Soc.*, 1947, 73, 426.

Improved Spent Oxide Burner

ECONOMICAL dispersal of spent iron oxide—a by-product in removing sulphur from coke oven gas in ammonia manufacture—was one problem at the Flixborough works, near Scunthorpe, Lincolnshire, of Nitrogen Fertilisers Ltd. A secondary problem was the production of residues suitable for re-use as coke oven gas purification material.

The firm designed a new burner which they operated as a pilot plant for about eighteen months before development on a commercial scale. Fully commissioned only a few months ago, the burner is now producing 17 tons of sulphuric acid a day from the sulphur recovered from the coke oven gas, and has already attracted the attention of other sulphuric acid producers at home and in other countries.

This burner can be operated so that, after the 'burning' of the sulphur, the residues discharged from the furnace can be re-used for the extraction of sulphur from the coke oven gas.

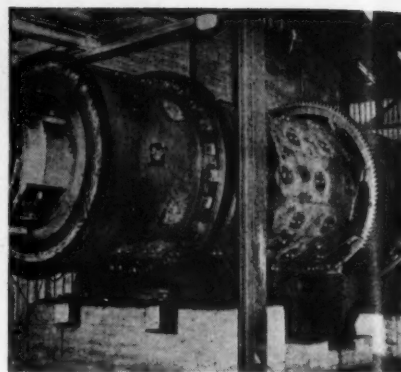
The burner is a rotary kiln, 25-ft. long by 6 ft. 9 in. in diameter, lined with refractory bricks and fitted with a special alloy steel centre tube. The spent oxide enters the kiln at one end and, in passing through, combustion of the sulphur takes

place. The residues of iron oxide are removed from the other end of the kiln by a rotary valve and conveyed to a bunker.

To ensure efficient combustion, the kiln has lifters which, as it rotates, cascade the spent oxide through the air over the full cross-section of the kiln. Air for combustion enters the kiln at the same end as the spent oxide and, after passing to the end where the residues are extracted, returns along the inside of the steel centre tube. The centre tube acts both as a means of ignition for the cold spent oxide entering the kiln and as a secondary combustion chamber. There must be complete combustion of the sulphur and carbonaceous matter in the spent oxide or troubles might arise in the sulphuric acid process later.

The burner, it is claimed, is proving very economical to operate. For maintenance it can be cooled down in 24 hr., compared with a week for the traditional type of furnace, and can be back in production again within 12 hr. after repairs.

The use of the burner makes other internal economies possible. By using the sulphur recovered from the coke oven gas instead of selling it to other consumers, the firm expect to save over £5,000 p.a.



The new burner, which produces 17 tons/day of sulphuric acid.

It is anticipated that another £4,000 p.a. will be saved by using the iron oxide residues as purifying material to recover sulphur from the coke oven gas, and the company's consumption of imported Spanish pyrites will be reduced by 4,000 tons a year.

The Flixborough works, which covers 28 acres, employs some 320 people from Scunthorpe and the surrounding district. The main product is sulphate of ammonia for the parent companies—Fisons Ltd., of Ipswich, and the West Norfolk Farmers Manure and Chemical Co-operative Co. Ltd., of Kings Lynn.

Positive ventilation. In their latest publication (No. 3702) Sturtevant Engineering Co. Ltd. describe the various applications of their cold-air douche system of positive ventilation. Primarily this system is intended to supply fresh air to operatives working at sources of intense heat. Ventilation is provided by a centralised centrifugal fan, which distributes air through a duct system with branches and downcomers at 'hot spots' fitted with dampers and swivelling outlets which can be adjusted by the operatives. Where less drastic treatment is suitable, fixed discharges from overhead trunking or swivelling fans are used. For the lighter industries, there is the Sturtevant supply equipment, which is a variant of the cold-air douche system in that the ventilation plant is more in line with the orthodox plenum system of ventilation. For the cooling of products and machinery, air filters of various types are used ahead of the inlet of the centrifugal fans.

Welded chemical plant. Robert Jenkins & Co. Ltd. have issued a new catalogue which illustrates the breadth of their manufacturing interests. These range from domestic boilers to chemical plant, and from galvanised tanks to stainless-steel fractionating columns. This handsome 70-page publication is fully illustrated with photographs and diagrams. Of particular interest is the section describing the special shop for fabricating in stainless steel.

Synthetic Resin Cements in Chemical Engineering

Synthetic resin cements are being increasingly used for jointing and assembling chemical plant. Recently the subject was discussed at a joint meeting of the Chemical Engineering Group and the Plastics and Polymer Group of the Society of Chemical Industry. F. K. Earp, F. Shapiro and A. E. Wiggs of the Morgan Crucible Co. Ltd., contributed a paper in which they discussed research which led to the conclusion that cashew nutshell resin cements were the best for joining carbon bricks or assembling carbon plant. Here is an abstract of their paper.

THE construction of chemical plant often requires the installation of chemically-resistant linings of various kinds; such linings may consist of rubber membranes, acid-proof brick, or tiles in ceramic compositions, coke-sulphur, or carbon. Typical uses include steel-pickling tanks, neutralisation pits, sulphite digesters, protected gulleys and floors, crystallisation tanks, etc. In these applications there is some form of outer casing, which essentially acts as a support for the lining whose function is to supply the necessary resistance to chemical attack and mechanical erosion. A problem normally arises as to how the lining is to be fixed to the outer casing. It is nearly always true that the effectiveness of the assembly depends to a very large extent on the physical and chemical properties of the materials used to cement or fix the linings. The chemical engineer and chemist are faced with the problem of suggesting a jointing or fixing cement which possesses chemical properties as good as or better than that of the main lining material. In many cases it is quite impossible to use a jointing material which has a chemical resistance as good as or better than that of the brick or tile used, and thus it is the cement which may ultimately determine the conditions which the completed plant will withstand. This point is often little appreciated by design engineers and by those setting out to install lined chemical plant.

In this paper a typical problem is considered which any manufacturer of a chemically-resistant constructional material meets when he wishes to market his product. In the particular case chosen as an example, consideration was given to the use of bricks and tiles made of hard carbon, having high mechanical strength, good abrasion-resistance and excellent resistance to all corrosive chemicals with the exception of oxidising acids in strong concentrations. The conclusion was soon reached that it would be impossible to find a cement for the bricks or tiles which surpassed them in chemical resistance; the only hope was to develop or choose a cement which withstood those chemical conditions which would be most generally met; at the same time it would be necessary to consider mechanical and other physical properties in detail.

A 'cement' is not to be confused with an 'adhesive,' which is normally used for

producing very thin glue joints of very high strength. By a 'cement' is meant a material which is applied in relatively thick layers or joints, from $\frac{1}{8}$ in. to $\frac{1}{2}$ in. in a variety of sites, under widely different conditions and with materials whose surfaces normally require no special grinding or machining treatment before assembly.

There are generally two broad types of 'cement,' namely a 'mortar cement' used for making joints between bricks, tiles or other forms of material, and a 'membrane cement' used for backing chemically-resistant linings or floors to act as an impermeable barrier to any corrosive liquids which may seep through the lining.

Requirements

The ideal requirements of a chemically-resistant mortar cement are: ease of application, ability to retain a reasonable working life, good strength and freedom from brittleness after setting, chemical resistance and good adhesion characteristics.

The ideal requirements of a membrane cement include all those given above for mortar cements but, additionally, a membrane cement must be impervious and should preferably retain a good measure of elasticity.

Realising that no ideal cement exists, or is ever likely to exist, the aim must be to choose materials which come as close as possible to the ideal and which meet the most attractive economic requirements in a given set of chemical and physical conditions. The first consideration must be the properties of the material to be jointed, since it may be possible to use a mortar cement which actually helps to overcome some of the less desirable properties of the lining materials. In the example considered, the industrial carbon products for which a cement was required were in the form of bricks, tiles or other parts for assembly into such apparatus as graphite heat exchangers, cascade coolers, absorption towers, etc.; the materials possessed a transverse breaking strength of about 1½ tons/sq.in. and, although mechanically strong, were somewhat brittle, so that a cement with some degree of resilience is to be desired. As a measure of minimum chemical resistance, it was agreed that the ability to withstand all the common mineral acids up to high concentrations, caustic alkalis, oxidising salts like ferric chloride,

halogens and common solvents, should form the objective.

Assessment tests

Assessment tests should be designed around the ideal requirements already referred to, but, in addition, wherever possible, tests should be carried out on an actual jointed specimen, so that both cement and base material are tested together. This latter point is very important and seems often to be overlooked by manufacturers. In the work under consideration the following tests were carried out: storage properties, application, setting and joint preparation, density of material and covering power, strength of joint, chemical resistance and operational testing.

The following basic synthetic resins and plastics were investigated on the basis of assessment already given: (a) phenol-formaldehyde resins; (b) furan-type resins; (c) aniline-formaldehyde resins; (d) vinyl resins; and (e) cashew nutshell resins.

As a result of extensive tests it was concluded that cements based on cashew resins provided the best choice for a material for joining carbon bricks or assembling carbon plant, bearing in mind the practical uses to which carbon is put. At the same time large quantities of cashew cement, developed for carbon fabrication, have been sold in the last five years for other applications.

A straightforward cashew cement of the following composition:

Part A:

Cashew resin 'Epok' H816

Part B:

Coke powder (fine-mesh)	300
Graphite powder (fine-mesh)	100
Paraformaldehyde	100

(5 parts of A are mixed with 3 parts of B)

was found to form a useful basis for a membrane cement to act as an impervious backing to the main chemically-resistant lining.

One great advantage quickly discovered was that a fairly simple cashew cement using coke or graphite fillers could be used as an impermeable membrane, which is obtained by spreading with a trowel or other implement. Adhesion to Portland cement-rendered brickwork or concrete is of a high order. Adhesion to metal tanks is not so good, but may be improved by increasing the percentage of graphite filler.

Membranes thus produced harden fully after several days without heat, but heat from braziers or electric fires applied the day after laying the membrane accelerate hardening to give a usable material after about 24 hr. The hardened material retains some elasticity and does not become really brittle for many months.

The non-dilatant cashew cements are essentially mortar cements which, while giving strong joints, are not necessarily completely impermeable, so that their use is limited to jointing applications.

A typical formulation is as follows:

	Parts
Cashew resin ('Epok' H630)	1,000
Caustic soda	5
Ethyl alcohol	100
Carbon (30 to 160 mesh) ..	1,200
Paraformaldehyde	50

One-component cement

A further interesting form of cashew cement can also be produced by using an emulsion of cashew resins in water, mixing with fillers, adding formaldehyde to the mixture and storing in airtight vessels. This enables a one-component cement to be produced, since the aldehyde dissolves in the aqueous phase and reacts with the resin only when the water is lost by evaporation or adsorption into lining materials. Such cements are only in an early stage of development; difficulties to be overcome include rather short storage life and dilatancy, which appears much more pronounced with emulsions than with the resins alone.

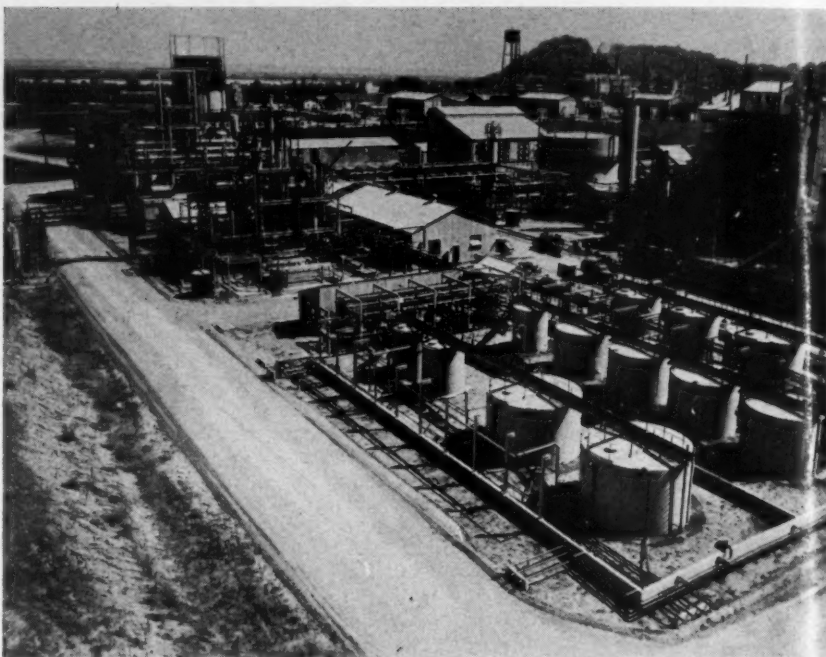
Very extensive tests have been carried out which have demonstrated that cashew cements compare very favourably with the other types of cement referred to, and are particularly suitable for carbon linings.

Other uses

Apart from bricks and tiles, synthetic resin cements may also be used for assembling quite different chemical plant, such as bundle heat exchangers, cascade coolers, etc., and here the problems are often very difficult: in a carbon heat exchanger with 44 tubes there are 176 cemented joints to be made, each joint has to be impervious, and must always be capable of withstanding 25 p.s.i. steam pressure. In certain cases, 40 p.s.i. is demanded. The cements capable of use in such applications are much more limited in number and the phenolic cement, however heavily filled, is generally too permeable and too brittle. Furan or cashew types seem to be best.

Research on new cement resins is always going on and may eventually lead to improved materials, but it should be borne in mind that such cements are sold on a tonnage basis and that costs of materials and installation are very important and competitive, so that although P.T.F.E., epichlorohydrins and other new plastic materials may be found to offer advantages in chemical properties, their present high cost rules them out for cements.

Synthetic Liquid Fuel Plants



The gas-synthesis demonstration plant of the Bureau of Mines, Louisiana. Employing a modified Fischer-Tropsch process, this plant converts coal to oil. Left to right: The synthesis unit, the product storage area (foreground), the oxygen unit (building in front of the water standpipe in background), the coal gasification unit (tall structure at right) and the coal storage area.

(All photos by courtesy of U.S. Bureau of Mines)

SEVEN years of co-operative research by the U.S. Bureau of Mines and private industry have transformed oil shale from a material that seemed to offer little hope of utilisation for producing synthetic liquid fuels in 1944 to one so promising that it would now be prudent for private industry to construct a prototype commercial oil-from-shale plant. This was recently reported to Congress by the Secretary of the Interior, who reiterated his previous recommendation that private industry, with such Government assistance as may be available, proceed to construct pioneer commercial plants to produce synthetic liquid fuels from both oil shale and coal.

'Sooner or later,' the report observes, 'our nation will rely in part on synthetic liquid fuels, and from the standpoint of national security it is essential that we be fully prepared when the time comes.'

A few recent major accomplishments under the Synthetic Liquid Fuels Act of 1944, the report shows, included putting into operation on a demonstration plant scale a new process for producing liquid fuels from coal synthesis gas, completing cost studies for commercial plants to produce liquid fuels from both coal and oil shale, gasifying powdered coal with oxygen under pressure on a pilot-plant scale, and starting construction of a 300 ton per day oil shale retorting plant.

The Secretary's report is issued in two volumes, one dealing with coal and the

other with oil shale, and describes in detail the scientific and technological work done in 1951 on the production of synthetic liquid fuels from both of these raw materials. In addition, the summary reviews briefly some of the accomplishments during the past seven years in all phases of the oil shale programme, from developing extremely low cost mining methods to producing satisfactory refined products.

During 1951 a 50 barrel day gas synthesis demonstration plant was completed at Louisiana, Missouri, and successfully underwent its initial test runs. This is the nation's first gas synthesis plant of this type. In addition, considerable progress was made toward developing an economical process for direct gasification of coal in Bureau laboratories and pilot-plants at Morgantown, West Virginia.

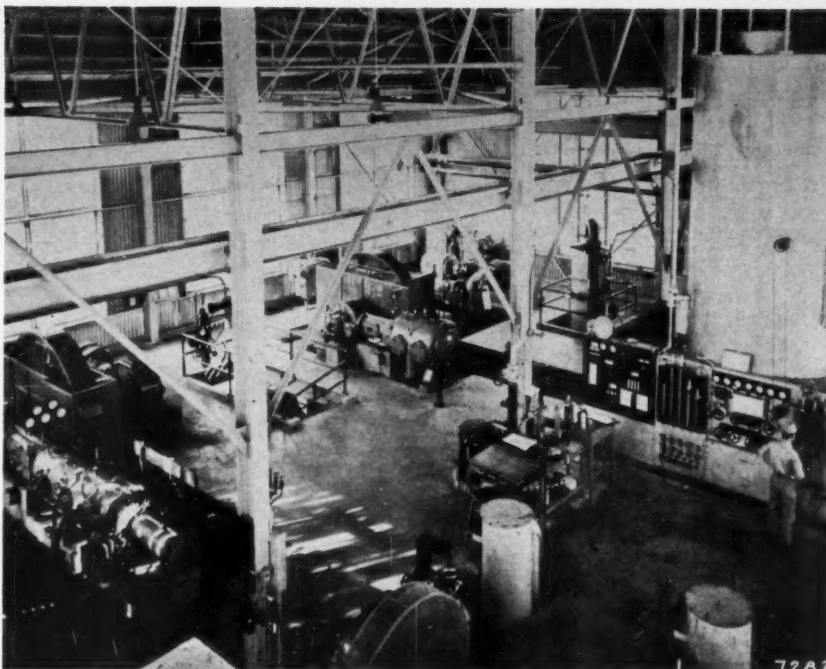
Research at Morgantown centred upon the gasification of powdered coal with oxygen under pressure, upon purification of the resulting gas to produce synthesis gas, a carbon monoxide-hydrogen mixture, and upon recovery of sulphur removed during purification.

At Gorgas, Alabama, in co-operation with the Alabama Power Co., experiments in underground gasification of unmined coal were continued. The second experiment was completed, and a third, utilising the electro-linking method previously tested by the Sinclair Co. in co-operation with the Missouri School of Mines was begun.

This method eliminates the need for underground work by utilizing an electric current to ignite the coal bed and open a channel between boreholes. Better quality gas was produced during the third experiment, which continued into 1952, than during either of the others.

The coal hydrogenation demonstration plant at Louisiana, Missouri, continued to produce liquid fuels which were tested with satisfactory results in Bureau of Mines and military vehicles. Its product streams also contained a variety of useful chemicals. On the basis of experience with this plant and of laboratory and pilot plant tests at Pittsburgh and Bruceton, Pennsylvania, process refinements were developed which improve the economics of coal hydrogenation.

The Bureau's cost estimates for coal hydrogenation, mentioned earlier, were made for hypothetical commercial-sized plants at Rock Springs, Wyoming, and in western Kentucky. These sites were chosen, the Secretary emphasised, not as preferred locations for actual plants, but as representative of extensive coal-bearing areas. Rock Springs was selected for study because it represents a Wyoming coal area with large reserves, and western Kentucky because it is representative of coal areas in Kentucky, Indiana and southern Illinois. During the year Ebasco Services Inc., a prominent engineering, management and consulting firm, was engaged to make an independent check of some of the more important items in the Bureau's cost estimate for coal hydrogenation. The Ebasco check included a detailed study of two important construction elements, six major operating cost factors, the marketability of



Oxygen is produced here for use in gasifying coal. Air is liquefied at temperatures more than 300 F. below zero and the nitrogen is removed, leaving high-purity oxygen.

chemical co-products, company-financed housing requirements, and methods of financing initial plants. This study, the report notes, supported many of the important cost factor estimates of the Bureau. Both the Bureau's estimates and Ebasco's findings were based on costs and economic conditions as of January 1, 1951.

The report notes that something in the

way of Government incentives to private industry appears to be required at this time, making the following quotation from the Ebasco findings:

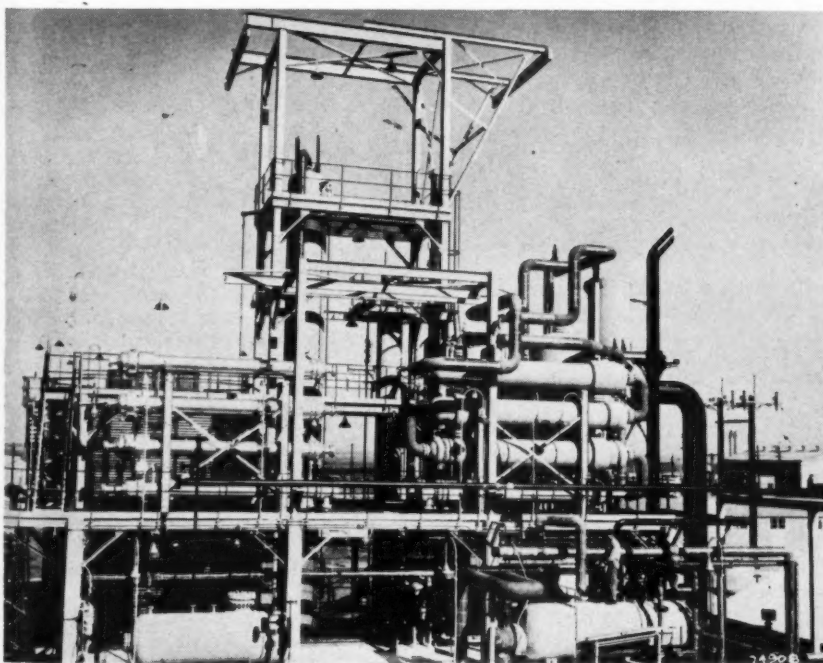
'We do not believe it would be feasible to finance the projects described in the Bureau of Mines report dated October 25, 1951, with private capital under conditions prevailing at January 1, 1951.'

Turning to oil shale, the Secretary's report notes that one of the year's outstanding events at Rifle, Colorado, was the start of construction of a 300 ton/day Bureau-developed gas combustion retort. The soundness of the gas combustion technique, which requires no external heat-exchange equipment and no cooling water, previously had been established on a pilot plant scale. Shale mining during the year was largely restricted to the needs of the oil shale demonstration plant and little mine development was undertaken. However, some progress was made in drilling techniques.

Operations at Rifle during the year provided much of the information needed for adapting conventional thermal refining techniques to treat shale oil. The gasoline produced, the report adds, is being used regularly in plant vehicles. Its performance appears equal to that of the corresponding petroleum product, as does that of shale diesel oil, which has been used in the plant trucks and equipment for nearly two years and also has been subjected to extensive testing in diesel railroad locomotives.

The Bureau made detailed cost estimates for a 250,000 barrel/day oil shale operation,

(Concluded on page 142)



Auxiliary equipment and piping of the synthesis reactor.

Utilisation of Solar Energy

As reported in our December issue, a committee sponsored by the Department of Scientific and Industrial Research has been examining the possibilities of utilising solar energy. Their conclusion is that at present there is no way in which the sun can make a large contribution to our sources of power. However, before reporting this conclusion, they consider in interesting detail the direct use of solar energy to produce power, the direct generation of electricity, and the production of fuel by photosynthesis in non-living systems, by the use of plants, and by continuous biological synthesis. Finally, they discuss the distillation of water, one of the few practical uses of solar energy about which they are optimistic. These parts of their report are reproduced below.

Production of power

OWING to the intermittency of the supply, the direct use of solar energy for driving engines need not be considered for large power plants. There are, however, a number of purposes for which intermittent power as low as 1 kw. would be useful. In particular, the economy of the Indian village might be profoundly affected by the availability of such prime movers for water pumping. Their use for driving the small looms used in cottage industries has also been suggested, but the intermittency of the supply makes it doubtful if they would be acceptable for this purpose.

As a basis of calculation we assume that 1 kw. of power is required during the hot weather in India. The optimum temperature for running a small steam, vapour or hot air engine would probably be about 200°C. A temperature higher than this would reduce the efficiency of collection and a lower temperature would reduce the efficiency of the engine. The efficiency of collection at such a temperature would not exceed 50% and to attain this figure at 200°C. a mirror collector would be required. The limit of efficiency set by the laws of thermodynamics for an engine working between 20 and 200°C. would be 38%. Mechanical and irreversible thermal losses would reduce this to about 14%. With these efficiencies we should get an average of 0.056 kw./sq.m. of useful power during the part of the day when the sun was shining brightly. For a power of 1 kw. the area required would be 18 sq. m. The efficiencies assumed are somewhat optimistic, but even so the area of mirror required is so large as to make the scheme too expensive for use in peasant agriculture. This conclusion might be modified if a suitable flat-plate collector could be developed, though it would then be necessary to work at a lower temperature with a corresponding loss in engine efficiency and increase in area.

The pumping of water from bores requires more power than the pumping of water from canals or rivers. The average connected load for over 2,000 State-operated wells in the United Provinces is 10 kw. per well, and this load is used to about 40% of capacity (Indian Central Electricity Commission, 1951). The use of solar engines to supply this would require impracticably large collectors.

Direct generation of electricity

We are thus regretfully forced to the conclusion that orthodox heat engines driven directly by solar power are not an immediate practicable proposition. We have also considered the possibilities of the direct generation of electricity by solar power without first converting it to mechanical energy. There are three known ways of doing this: by the thermoelectric effect, by a photovoltaic cell, and by the photogalvanic effect.

Thermoelectric effect. With existing materials the efficiency of the conversion of absorbed heat into electric power is about a quarter of the thermodynamic efficiency, or rather less than that of a small steam engine working between the same temperatures. This might be raised somewhat by the production of improved thermoelectric materials, but it seems unlikely that the scheme could be made substantially more efficient than the steam engine. It has other disadvantages. With a temperature difference of 200°C. and the very high thermoelectric power of 4×10^{-4} v./°C., 250 junctions would be required to produce 20 v., of which only 10 v. would appear in the external circuit. If a power of 1 kw. is required, these 250 junctions must have a resistance of less than 0.1 ohm. The equipment will clearly be of considerable complexity and a large bulk of relatively expensive materials will be needed. A serious practical difficulty would be the disposal of the large amount of unused heat.

Photovoltaic cells. The efficiency of these cells is determined by the quantum yield, that is the number of electrons liberated per quantum absorbed, and by the fraction of the energy of the quantum that is converted into energy of the electron. Both these can be quite high in certain parts of the spectrum. Selenium is the most favourable of known materials and gives a quantum yield of up to 75%. The fraction of the energy of the quantum converted may be as high as 15%. Of the power produced, only about 36% appears in the external circuit when the conditions are adjusted to give the highest efficiency. These figures give an efficiency of 4.1% at the most favourable region of the spectrum (in the green). The use of sunlight instead of green light reduces the efficiency to 0.53%. This figure gives 1.1 w./sq.m. for an average incident energy

of 0.2 kw./sq.m., and a peak of 6 w./sq.m. This very low figure can only be improved by extending the spectral range of the cell into the infra-red without sacrificing its other properties. We do not consider that it is necessary to give any special encouragement to the improvement of photovoltaic cells for power production from solar energy. There is, for other reasons, a strong incentive for their improvement and the prospects of their useful employment for power production do not seem good enough to justify extra effort in that direction.

Photogalvanic effect. It is in principle possible to construct a photogalvanic cell in which a chemical change is stimulated by sunlight, and which in consequence produces electrical power. The little that is known about these systems makes it appear most unlikely that they could be developed into an efficient source of power.

Production of fuel

The use of solar energy to produce fuel which is subsequently used in an engine is attractive, as it avoids the consequences of the intermittency of sunlight and allows the energy to be used in applications requiring the continuous production of power.

Photosynthesis in non-living systems. Most photochemical reactions lead to a release and not to a storage of chemical energy. The basic reason for this is that if the primary action of light is to break a chemical bond either the same bond, or one energetically more stable, is formed. The photochemical combination of hydrogen and chlorine is an example of the latter process. It is only in very special and complicated systems that photosynthesis of compounds with more energy than the raw materials is possible. In fact, no suitable non-living systems are known and, in the present state of photochemistry, there is little chance of finding any in the near future.

Research on photosynthesis is of great importance for many reasons, but we do not believe that at present any attempt should be made to divert workers in this field to the study of potential fuel-producing systems.

Use of plants to produce fuel. The efficiency of the utilisation of sunlight by growing plants is remarkable. *Eucalyptus globulus* in India gives 2.4 kg. of wood per

year per sq. m. (9.4 tons/acre/yr.). The wood has a calorific value of 2.1×10^4 joules/g. (5,000 cal./g.). The rate of storage of energy in the wood of an Indian eucalyptus forest is therefore 1.6 w./sq.m. or 0.8% of the energy reaching the ground. The yield from annual plants is of the same order. For example, Spoehr (1926) states that the annual yield of sugar cane is 3.8 kg./sq.m. (15 tons/acre). With a calorific value of 1.7×10^4 joules/g. (4,000 cal./g.), this would give 2 w./sq.m.

If the wood of a eucalyptus forest is burnt and used in a steam engine with a boiler efficiency of 70% and an engine efficiency of 14% (this is higher than has yet been achieved in small commercial engines, which give about 5%), it would yield 0.15 w./sq.m. of forest. The alternative of fermenting vegetable matter to alcohol and using this in an internal combustion engine yields less power owing to the small proportion of the plant that can be converted to alcohol. For example, according to Spoehr ('Photosynthesis,' New York, 1926) a kilogram of sugar cane yields only 60 g. of alcohol. With a calorific value of 3.1×10^4 joules/g. (7,400 cal./g.) this would give 1,860 joules/g. of sugar cane or 0.22 w./sq.m. With an engine efficiency of 30% the useful power obtained would be 0.07 w./sq.m. It seems unlikely that it would be worth while growing plants for fermentation, though in favourable circumstances the use of waste material may be profitable.

As an alternative to fermentation to alcohol; an anaerobic fermentation to methane is possible for some kinds of vegetable matter. Ruheman, Immerwahr, Theedam and Arnott have shown that in this way, using the water hyacinth (*Eichhornia crassipes*), 400 joules (95 cal.) can be obtained from a gramme of the green plant; this is equivalent to 2,400 joules (460 cal.) per gramme of dry material. This is of the same order as the heat obtained by burning the alcohol from cane sugar, but is so much less than the calorific value of any vegetable matter (3,000 to 5,000 cal./g. for dry material), that the process seems unlikely to be economic unless large quantities of a material that was incapable of direct burning were available.

The above figure of 0.15 w./sq.m. for the production of power by burning wood is much less than that for the production of power directly from solar energy (see beginning), but the area is an area of forest and not an area of engineering equipment.

An estimate can be made of the possibilities of the wood-fired steam engine for irrigation.

If it is assumed that the land to be irrigated requires during the year the equivalent of 0.5 m. of water to be raised from a depth of 10 m., it can be shown, using the figures given above for yield, calorific value and efficiency, that the amount of land required for growing fuel for the engine is about one-fiftieth of the

area to be irrigated. The value assumed for yield is what would be obtained under good conditions and is substantially greater than would be expected from peasant holdings. Even if a factor of 5 is allowed on account of optimistic assumptions, the project still seems practicable.

A significant comparison is with the bullock, which is the commonest method of obtaining power on smallholdings in India. An Indian bullock has been known to exert a force of 0.16 tonnes at 1.6 km./hr. for 8 hr. For this period the bullock was producing 0.72 kw. The average performance of bullocks in good condition is probably a third of this. The average for a 24-hr. day is therefore 80 w. The mean of five summer rations for Indian bullocks suggested by one authority is 12 kg./day (dry weight 7 kg./day). The winter rations are larger (30 kg./day for the one example given), but the dry weight of 8 kg. is not very different. With a calorific value of 1.7×10^4 joules/g. (4,000 cal./g.) the bullock is consuming food which if burnt would give 1.5 kw. of heat. Its efficiency is therefore about 5%. Put in another way, a bullock produces an average power of 80 w. and consumes about 2.7 tonnes (dry weight) of food in a year. To get 80 w. by burning wood would require 1.2 tonnes of wood.

Thus from the point of view of thermodynamics the wood-fired steam engine has advantages over the bullock as a source of power. There is a further advantage that the steam engine does not need to be supplied with fuel when it is not working or when it is too young or too old to work. It can therefore save fuel when power is not needed and use it all during the season when water pumping or ploughing are required. In addition, the steam engine will probably be used with more efficient pumps and ploughs than will the bullock. This may be a considerable gain, as the efficiency of indigenous Indian water-raising appliances is only about 35%.

The disadvantages of the steam engine are high first cost, the lack of fuel and the lack of versatility. It would be difficult to use the same steam engine for pumping, ploughing and as a means of transport. These objections may well make the replacement of the bullock by the steam engine a very slow process. Nevertheless, it does seem desirable that a small steam engine fired by vegetable matter should be designed. It is possible that such an engine might be of value in some areas where coal and oil fuel are not available but wood or other suitable plants are.

The production of large amounts of power by burning wood is, in principle, possible. To produce 10,000 kw. with a power station having an overall efficiency of 32%, would require 20 sq. km. of forest. That is, this area of forest could yield every year, for ever, enough wood to fire the boilers of the power station. There is a large margin of uncertainty in the estimation of the yield of timber, and that

assumed is probably optimistic. The project does not appear attractive, but is not entirely impracticable.

The widespread use of plants as a source of power would require so large an area of ground as seriously to affect the area available for growing food. Spoehr (1926) points out that if half the food produced in the U.S.A. during an average year between 1913 and 1918 were fermented to alcohol, it would just be able to replace the 1920 gasoline production. Such a comparison shows how entirely inadequate such a source is to provide an amount of power comparable with that at present in use.

The above estimates are based on the rate of production of vegetable matter by existing plants. It is conceivable that higher rates could be achieved by breeding plants specially for high rates of production. This would only be possible if the rate of production were not limited either by the usable energy received or the amounts of carbon dioxide or other necessary material available.

Continuous biological photosynthesis. It has been suggested that some form of plant could be grown in tanks and continuously withdrawn and burnt, or fermented to alcohol. The attraction of this scheme is that it provides a process by which mechanical or electrical energy can be obtained continuously from sunlight without the consumption of any material substance.

The efficiency of the photosynthetic process in systems of the kind contemplated is in some doubt. Recent work gives up to 65% of the absorbed energy as usefully employed. This result is not universally accepted and many authorities consider that the efficiency is only about 25%. To give a high efficiency for photosynthesis the incident energy must lie within a certain range of wavelengths; outside this range the efficiency falls. The variation of efficiency with wavelength is even more uncertain than the absolute value. A reasonable guess would perhaps be that 30% of the energy is used with an average efficiency of 25%, giving an efficiency of 7.5% for the transformation of solar energy into chemical energy. If the plant material were filtered off and burnt, about two-thirds of this energy would be obtained as useful heat; the remainder would be used in drying the plants and could not be recovered except at so low a temperature as to be useless for power production. This gives 5% of the incident energy or 10 w./sq.m. of useful heat. With a power station efficiency of 32%, we get 3.2 w./sq.m. as the power produced. These figures are summarised in Table 1. Fermentation of the plants to alcohol or methane is also possible, and possibly more convenient, but would yield substantially less power.

Owing to its complication, such a scheme would only be possible on a fairly large scale. A power station producing

Table 1. Production of power by continuous photosynthesis

	%	w./sq.m.
Solar constant ..	100	1,300
Yearly average ..	15	200
7.5% transformed to chemical energy ..	1.1	15
Useful heat ..	0.8	10
Useful work ..	0.26	3.2

10,000 kw. would need 3.1 sq. km. of tanks. The depth of the tanks would have to be sufficient for the greater part of the light to be absorbed by the plants. It is not known what thickness is required, but it would probably be at least 30 cm. If this is so the volume of water would be 0.9×10^6 cu. m.

With a calorific value of 1.7×10^4 joules/g. (4,000 cal./g.) and a power station efficiency of 32%, the weight of dry plants consumed would be 5.8 tonnes/yr./kw. or 58,000 tonnes/yr. for a 10,000-kw. station. To get this from 3.1 sq. km. of tanks requires a productivity of 19 kg./sq.m./yr. This is about five times higher than the highest rates achieved naturally. This high rate is a result of the assumption that conditions can be produced under which the rate of growth is controlled only by the light available. As so high a rate is obtained on this assumption it would be necessary to be sure that there was not some other limiting factor. In particular it would be necessary to recover the carbon dioxide obtained by burning the plants and return it, possibly in the form of carbonates, to supply carbon for the next batch. It would also be necessary to recover or supply nitrogen, potassium and some other elements in a suitable form. The amounts to be handled are considerable; for example, most vegetable matter contains $\frac{1}{2}$ to 1% of potassium oxide. The amount required in a year is therefore 300 to 600 tonnes. Even more nitrogen would be required. The disposal of the heat not used by the plants might also be a serious problem, since for a 10,000-kw. station it would reach over 3×10^6 kw. at midday in summer.

On the figures given above the scheme is clearly impracticable. An area of 3.1 sq. km. of tanks, which might have to be covered, is too great to be considered for the production of 10,000 kw. A reduction at least by a factor of 10 is necessary. An examination of Table 1 suggests that this can only come from an increase in the efficiency of the conversion of the sun's radiation into chemical energy, by increasing the range of wavelengths used or by increasing the efficiency of use of those wavelengths that are used. On present evidence it does not seem that such substantial improvements are possible. If, at some future time, the cost of fuel becomes very much greater than at present, such possibilities might require serious consideration.

We have considered only the production

of power from algae and have regarded their cultivation for food as outside our terms of reference.

Distillation of water

There is scope for the solar distillation of water for drinking purposes in certain tropical areas. On the assumption that an average of 0.15 kw./sq.m. of radiant energy is available, the evaporation by direct distillation at 100°C. would be approximately 5 kg./sq.m. of heat surface per day. Distillation at pressures below atmospheric would not reduce the heat required per kilogramme of water, but the efficiency of heat collection would be greater because of the lower temperature. Considerable improvements have been made recently by introducing black dyes into the solution to increase the proportion of the heat absorbed.

There is considerable scope for a combination of solar heater and thermal pump. This system would enable almost complete recovery of the latent heat of condensation, and would greatly increase the output for a given size of plant.

Conclusions

There is at present no way in which the use of solar energy can make a large contribution to our sources of power, and no line of research and development can be suggested that is likely to lead to a way in the near future.

Energy for domestic hot-water heating can in favourable circumstances be obtained and there is scope in certain tropical areas for the distillation of water using a combination of solar heater and thermal pump. The committee recommends that a cooking stove, utilising solar energy and suitable for large-scale production, be designed.

The development of air-conditioning equipment driven by solar power is worth consideration as is the design of a flat-plate collector for driving a small engine.

A small steam engine of high efficiency using wood or other plant material as fuel appears to have substantial advantages over power derived from animals for pumping water and driving light machinery. The development of such an engine is desirable and is being undertaken by Messrs. Ricardo for the National Research Development Corporation.

Synthetic Liquid Fuel Plants

(Concluded from page 139)

incorporating the newest developments in mining, retorting and refining. Two refining plans were considered, one using basic thermal cracking and the other a mild hydrogenation process developed by the Union Oil Co. of California. Based on a capitalization of 50% equity and 50% borrowed funds, the report estimates the rate of return on equity capital after income taxes at 8.4% for thermal refining and 11.2% for mild hydrogenation on the basis

of January 1951 prices for the products.

At the Bureau's petroleum and oil shale experimental station at Laramie, Wyoming, laboratory work on the development of a process for retorting oil shale at high temperatures reached the point where construction of a pilot plant was begun. The report explains that high-temperature retorting makes it possible to produce valuable chemicals, such as ethylene and benzene, from oil shale.

In its refining research at Laramie the Bureau developed improved methods for treating thermally cracked shale gasoline and improving distillate stocks for use either as diesel fuel or as catalytic cracking stocks.

The report is in two volumes. A free copy of 'Report of Investigations 4865, Part I—Oil from Coal,' and of 'Report of Investigations 4866, Part II—Oil from Oil Shale,' can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pennsylvania. The publication or publications desired should be identified by number and title.

Standard for Domed Ends for Tanks and Pressure Vessels

This British Standard (B.S. 1966: 1953) specifies the boundary dimensions of three types of dished and flanged, pressed or spun ends commonly used as end closures of pressure vessels, tanks and similar equipment, i.e.

(a) Deep dished and flanged ends (2:1 ratio):

(i) Of semi-ellipsoidal shape with a profile following (within the stated tolerances) the shape of a semi-ellipse with a ratio of major axis/minor axis of 2:1.

(ii) Of arc dished shape with a depth of dishing measured from a plane passing through the point where the straight flange joins the knuckle radius, equal to 0.25 times the inside diameter of the end.

A range of ends from 12 in. to 120 in. nominal diameters is given.

(b) Dished and flanged ends: having a depth of dishing measured from a plane passing through the point where the straight flange joins the knuckle radius nominally 0.169 times the inside diameter of the end. The nominal diameter may be either the outside or the inside diameter. A range of ends from 12 in. to 120 in. nominal diameters is given.

(c) Shallow dished and flanged ends (tank style): having ends dished to a large radius and provided with a knuckle radius of $1\frac{1}{2}$ in. The nominal diameter is the outside diameter of the straight flange. A range of ends from 36 in. to 108 in. nominal diameters is given.

Tolerances are given for circularity, thickness and profile, together with tables of dimensions in respect of inside or outside diameters, depth of dishing, dishing radius, knuckle radius and lengths of straight flange.

Chemical Engineering at the B.I.F.

THE 1953 British Industries Fair was held in London and Birmingham from April 27 to May 8. As usual, the engineering exhibits were concentrated at Birmingham. Below we give a description of some of the exhibits of new products of chemical engineering interest.

Fine grinder

A new fine grinder which can be completely and speedily dismantled, cleaned and reassembled without the use of spanners was exhibited by British Jeffrey-Diamond Ltd. This machine, the Intermediate Atomill, is the latest addition to the firm's range of fine grinders and has a product range from 50 to -300 B.S. mesh. Other noteworthy features include an automatic non-choking device, built-in safety guard for hand feeding, and an overall enamelled steel cover which provides a guard for the mill, motor and Vee-rope.

The mill will have special appeal to batch producers, particularly those in the chemical, colour and dyestuffs, cosmetics, food product and plastic industries, where it may be necessary to pass a variety of materials through the mill daily and where speed and spotless cleanliness are vitally important factors when changing from one product to the next.

The machine may also be used on continuous production. Recent tests on sugar showed a product of 99% passing 10XX silk (85% passing 300 mesh) at a rate of approximately 430 lb./hr.

The machine consists of a grinding chamber which encloses a high-speed dynamically- and statically-balanced rotor, driven through Vee ropes from a 10-h.p. electric motor fitted direct on to the baseplate. Grinding action is obtained by means of ten machined drop-forged hammers with tipped wearing faces which are attached to the rotor and drive the material against a serrated grinding liner of heat-treated steel. Material is transferred from the feed hopper on top of the grinding chamber by means of a power-operated feeder screw.

Provision is made at the base of the grinding chamber for the fitting of perforated screens which are supplied in varying degrees of fineness. The material is reduced to the desired size and discharged through the screens, oversize being swept round by the hammers for further reduction on the grinding plates. The screens play little part in the grinding operation, but act principally as particle retainers. The final product is discharged through the opening in the base of the machine.

The Intermediate Atomill cannot be choked, the feeding screw motor being so interlocked by the wiring between motors and starters that it can only be started up

when the main motor has attained running speed.

When the machine is to be used for batch production, and is hand fed, a protective guard fitted over the hopper mouth prevents the operator accidentally touching the revolving feeder screw.

The mill will handle capacities approximately 50 to 60% of those of the larger Atomill, although it is necessary to mention that both models are essentially 'customer-tested' units. In most cases, tests will have to be made on the material under consideration.

Porous ceramics

The Royal Doulton Potteries displayed a wide selection of porous ceramics such as are being used today in almost every branch of industry for filtration, diffusion, electrolysis and other processes.

In addition to their normal display of porous ceramics, Royal Doulton showed several novel exhibits. These included:

Diffusers. Six diffuser tanks were shown in operation, the object of these being, firstly, to give visual evidence of the difference in flow characteristics between the various grades of porous ceramic and, secondly, to indicate how the operating pressure has been reduced by the introduction of the latest type of diffuser material, known as 'D' materials.

Four of the tanks each contained two different grades of porous ceramic and in each tank the two diffusers were fed by a common air supply. The result was that the escape of bubbles from the coarser of the two grades was considerably more profuse than from the finer grade and, in fact, in one tank the pressure had been adjusted so that there was no passage of air through the finer-grade diffuser.

In the two remaining tanks, two of the ordinary ceramic diffusers, grade S3A and grade F10, could be compared with the latest 'D' grades, DS3A and DF10. The flow of air through these latter had been adjusted to match as closely as possible that through the corresponding normal grades in the other tanks. Grade DS3A required less than half the air pressure needed by grade S3A; grade DF10 required only one-sixth the pressure needed by grade F10.

A secondary display was made with a small DF10 diffuser fixed in the bottom end of a cylinder containing water. This diffuser had been running without break since August 13, 1952, no attempt having been made to filter the air supplied—from a small diaphragm pump—to the diffuser, nor to prevent the growth of algae or similar organisms in the water and on the diffuser. The ease with which the air passes through this diffuser gave ample proof of the efficacy of 'D' treatment.

Fluidisation. The small air-slide shown at last year's B.I.F. attracted a considerable amount of attention. It was succeeded this year by a display of a small storage hopper fitted with diffuser tiles and a miniature air slide. Demonstrations clearly indicated the way in which the discharge powder was assisted by the use of diffuser tiles. When the air supply was turned off only a proportion of the material could be drawn from the hopper, yet with air assistance virtually no material remained in the hopper.

Filters. New fields are being opened with the introduction of Royal Doulton large-size filter tubes into dust-recovery equipment. Progress in this application over the course of the past year has been considerable and has been augmented both by the successful production of filter tubes larger than any previously made in this country and by the introduction of a new grade of porous ceramic. The display of filter tubes included the largest size Doulton have so far been called upon to produce in large quantities, viz. 52½ in. long and 6½ in. diam. The new corundum grade of material is readily distinguished from the normal grades by its black colour, and it offers considerable advantages in its high mechanical strength and its suitability for use at elevated temperatures.

Among the display of industrial filter units was a pair of filter tubes fitted with tie-rods and a special type of top fitting which should prove of great interest to those concerned with the construction of large filter units. There was also an assembly, approximately 7 ft. long, of short porous ceramic tubes nested together with spigot and socket connections and clamped up on a tie-rod. Various industrial filter units such as stainless steel and rubber-lined units for corrosive liquors, a glass and stoneware pipeline unit, air filters, the Doulton Dechromator and other electrolytic cells were included.

In addition to the above, the display included a wide selection of various types and grades of porous ceramics used in industry, a chemical stoneware vacuum filter which had been sectioned for clarity, and various domestic water filter units which operate either under gravity or which can be connected direct to the main-water supply.

Carbon and graphite

Among the exhibits shown by the Morgan Crucible Co. Ltd. were Carbinert impervious carbon and graphite and Carblox refractories and chemical-resisting tiles. Carbinert is a material which combines many of the unique properties of carbon which are of the greatest value to the chemical engineer. These properties include chemical resistance to most acids

and alkalis, machinability, high thermal conductivity and availability in impervious forms. The material is being used in industry in a variety of applications, particularly in heat exchanger equipment handling corrosive fluids. Such equipment includes cascade coolers, bundle-type heat exchangers, plate heaters and bayonet heaters.

Exhibits showed how *Carbinert* is being used over a wide range of the chemical, process and textile industries.

Carblox, another carbon product (manufactured by *Carblox Ltd.*, an associate company) provides refractories for blast furnaces and tank linings. *Carblox* chemical tank linings combine high chemical inertness with excellent resistance to abrasion. A selection from the wide range of bricks and tiles available was shown.

The display of *Carblox* corrugated hearth blocks and standard shapes for blast furnaces was of especial interest. These materials have been proved to have a crushing strength and a resistance to abrasion which is appreciably higher than that of the firebricks normally used for blast-furnace linings.

Refractories

On another section of their stand, Morgan showed a number of refractories. The central feature of the display was devoted to the two new refractories recently introduced, which may well change the whole conception of furnace maintenance and efficiency. They are the super-duty firebrick (Morgan M.R.1) and the Morgan low-storage insulating refractory (M.I. 28).

The new M.R.1 super-duty firebrick offers a valuable contribution to improved productivity by giving longer life in those critical positions in furnaces, kilns, boilers, etc., where normal firebrick is liable to fail rapidly due to such factors as excessive temperature, slag attack and thermal spalling.

Many of the furnaces used in industrial processes are relatively inefficient, as much as 50% of the heat input being wasted in the furnace structure or conducted through it when ordinary firebrick alone is employed in the construction. By using reliable high-temperature insulating firebrick, capable of being exposed to furnace atmosphere, such heat losses can be substantially reduced, particularly in the case of gas- or oil-fired appliances.

The use of the Morgan low-storage insulating refractory as a hot-face lining in furnaces is claimed substantially to reduce heat losses, both by reduction in the heat actually stored in the brickwork and by the very much lower conduction of heat through the material. In intermittent furnaces, where, in addition to expensive fuel, time is also consumed in reaching temperatures, remarkable savings can be achieved resulting not only in lower fuel costs but also in increased productivity. Its use as a direct furnace lining produces greater uniformity of temperature with a

consequent improvement in the quality of the product being treated. As implied by its grade name, M.I. 28 can be used up to a maximum temperature of 2,800°F. (1,538°C.) either as a backing insulation or for the complete furnace lining itself in cases where conditions of slagging or abrasion are not severe.

Special air-setting cements are available for setting the M.I. 28 shapes, and also for wash-coating surfaces exposed to furnace atmosphere.

Typical examples of applications in which M.I. 28 can be used are: reheating, forging and annealing furnaces; periodic and continuous kilns; enamelling furnaces; oil-heating furnaces and oil stills; electric furnaces, boilers, combustion chambers and high-temperature flue linings.

Another exhibit was the new M.R. mouldable plastic, a super-duty plastic refractory of a stiff malleable consistency. It has a maximum operating temperature of 1,650°C. and is particularly recommended for service at high temperatures or where severe slagging or spalling is encountered. Careful selection of raw materials and a unique method of manufacture ensure uniform consistency and constant reliability of the product. The main characteristics of M.R. Mouldable are a high degree of refractoriness (P.C.E. 33/34), volume stability under high temperature and loading and freedom from spalling. The material was described in *CHEMICAL & PROCESS ENGINEERING*, April 1953, p. 115.

In addition to refractories and chemical-resisting carbon, Morgan exhibited crucibles, crucible furnaces, sintered metal products, carbon engineering components and graphite jointing compounds, greases and paints.

Industrial nylon cloth

Nylon cloth for industrial purposes was featured on the stand of British Ropes Ltd. Industrial overalls and all kinds of industrial filters are now being made from *Viking* nylon cloth products by the company in their Leith, Edinburgh, factory. A hydro extractor cover of nylon was of particular interest.

Ceramic filters

On the stand of Aerox Ltd., exhibits were in two main groups, the first being raw material in the form of special ceramic media, the second being complete units of various types. The first category of product may also be divided into two main sections, one type of media known as *Porsilex* being used mainly for filtration purposes; the other, known as *Celloton*, is a different type of ceramic material and is used mainly for electrolytic diaphragm applications. Finished Aerox units take the form of complete filter equipment for pressures up to 5,000 p.s.i. of air, gas and liquids, together with special equipment designed and built to perform unusual tasks. Containers and fittings are made in

a wide variety of materials such as stainless steel, brass, bronze, glass, aluminium, ebonite, rubber and plastic.

Typical examples of most of these units were shown, together with specimens of *Porsilex* and *Celloton* media. In addition, examples of *Petrox* chemical stoneware equipment with ancillary fittings were exhibited. This latter equipment is being marketed throughout the world by Aerox on behalf of an associate company.

Porsilex ceramic material is made in the form of tubes with or without flanges, open-ended cylinders, or in the form of pots, plates, discs and similar shapes. Pore sizes range from 5 to 200 microns and the correct choice of media specification is of great importance in ensuring the most efficient form of filtration of any particular specification.

Plastic moulding machines

Four new machines for the plastics industry were exhibited by R. H. Windsor Ltd., two completely new and two being improved and modified versions of standard Windsor models.

The new 1-oz. automatic injection moulding machine has been produced to meet the needs of both small and large moulders for a small, fast and reliable machine capable of producing articles both for the general commodity market and technical mouldings of industrial value. It has a capacity up to 2 oz. at 13,000 p.s.i. with an additional liner and plunger. Its plasticising capacity is 22 to 24 lb./hr. and is capable on a dry run of a maximum of 480 shots an hour.

Being fully automatic, a bank of these machines can be controlled by one operator. Special attention has been given to creating a trouble-free control system and the control gear for operating on full or semi-automatic cycle is completely mechanical, no electrical apparatus being used.

The machine has a direct hydraulic lock of 30 tons and an injection material plunger pressure of 20,000 p.s.i. The injection is interlocked with the clamp so as to ensure that injection cannot take place until the machine is locked.

The other completely new machine is the Windsor *SH2*. A 2-oz., fast-cycling, hand-operated moulding machine, it has been produced primarily to meet the needs of certain markets where British machines are in fierce competition with other European manufacturers. Whilst of high quality, it is extremely competitive in price. The first six of these off the assembly lines have already been sold to one of the largest toy moulders in the U.K. The hydraulic system has been specially designed so that the machine will be economical to run and operating is simplicity itself.

The plasticising capacity is 22 to 24 lb./hr., the pressure on material 13,000 p.s.i. and the maximum number of shots/hr. on a dry run is 480. The injection plunger has an area of 2.24 sq. in.

and a diameter of $1 \frac{1}{16}$ in. The length of its stroke is 5 in., it has a speed of 195 in./min. and carries a total load of 28,275 lb.

The third machine is a modification of a standard Windsor extruder, the RC 100-lb. extrusion machine having been considerably improved with many modifications made to it, based on experience gained in the last twelve months in the American market where many models have been used under severe production conditions.

One of the chief attractions of this machine is that it can compound, colour and extrude from pre-blended powder and colour-concentrate in a single operation. The modifications give it increased capacity and simplified operation and enable it to handle greater extrusion loads because of the 50% increase in thrust washer area.

Lubrication

The lubricating system now feeds water-cooled oil to the entire series of thrust washers on each screw, as well as to all gears and other moving parts. Splined screw construction permits easy removal of the working sections of the screws, leaving intact the after portion with thrust washer assemblies. A clutch has been added to disengage the feed mechanism automatically in the event of overload caused by oversize pieces of plastic or by contamination.

The fourth new machine is the new SH 8- to 10-oz. injection moulding machine. Its latest improvement is the inclusion of a hydraulically-operated retractable injection unit, comprising the material cylinder, the hydraulic pressure cylinder, together with the hopper and feed mechanism, all being advanced and withdrawn to provide easy accessibility. The convenience of this retractable unit to the operator is undeniable.

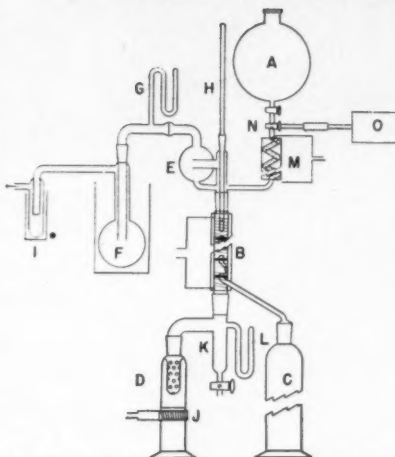
Also shown by Windsor at the B.I.F. was a standard RC 100-lb. extruder.

Welding equipment

The British Oxygen Co.'s exhibits included the Argonaut welding process, which was on show for the first time. This is an automatic welding process using an inert-gas-shielded arc with a consumable electrode. It has great scope for all-position welding on heavy-gauge aluminium plate and light alloys. It can also be used on stainless steel and copper-base alloys. No flux is needed and welds are of good quality, free from slags and inclusions. With multipass techniques there is no practical thickness limit and comparatively few passes are needed, because of the large amount of filler metal which can be deposited.

The new Argonarc spot welding equipment was also demonstrated. This equipment is suitable for spot welding stainless and bright mild steels. Access to one side of the joint only is required and material up to $\frac{1}{16}$ in. thick may be joined to any greater thickness or sections of any shape.

Deodorisation of Vegetable Oils



Modified Oldershaw column-type vacuum deodoriser.

TWO types of all-glass deodorisers have been found suitable for laboratory use for the collection of the volatile products from large quantities of oil. These can be operated semi-continuously, one on the bubble-cap principle, the other, which has the higher capacity, constructed from a modified 15-plate Oldershaw distillation column. Both columns, which effectively deodorise oils and remove fatty acids, are described by R. R. Allen, *et al.*, of Armour & Co., in the *Journal of the American Oil Chemists' Society* (1952, 29, (9), 380-382).

In the bubble-cap type the oil flows from the oil reservoir, which has a capacity of 1 l., through a drop counter, where an approximation of the rate of flow can be made, and thence into a glass column, 80 cm. long and 29 mm. in diameter, containing four bubble caps. The temperature of this glass column is controlled with a variable voltage regulator. A thermometer

is placed at the top of the bubble-cap column to register the temperature of the oil. A spray trap prevents the oil from being carried over with the distillate, which is collected in two dry-ice traps. A vacuum pump is connected to one of these, and the pressure is measured by a manometer.

The modified Oldershaw column-type deodoriser, shown in the diagram, has a 1-l. flask oil-reservoir A. The flow of oil into the evacuated system is controlled by a special stopcock N, the bore of which is sealed at one end to form a cup, and which is rotated at constant speed by the motor O. As the cup rotates it is alternately evacuated and filled with oil from the reservoir and the oil is discharged into the preheater M without change in pressure. From the preheater the oil enters the electrically heated Oldershaw column B, which is so modified that oil from the lowest plate drains into the oil receiver C. The flow of water vapour is controlled by a small ring heater J, which is kept just below the water level in the water reservoir D. The trap K catches the small amount of oil which drains from the column upon completion of deodorisation. The vapour from the column passes through the spray trap E into dry-ice traps F and I. A vacuum pump is attached at I through a pressure regulator. Pressures are determined by means of the manometers G and L. Temperatures are measured at the top of the column by means of the thermometer H. The column is heated to the desired deodorisation temperature, which is measured by means of a movable iron-constantan thermocouple. The oil then flows through the preheater into the column, and the temperature of the preheater is varied until the thermometer and the thermocouple indicate the same temperature.

Diaphragm device controls viscous liquid density

The density of citrus molasses and similar viscous liquids can be controlled during evaporation by means of a stainless-steel air pressure diaphragm controller installed at the bottom of a vertical column of constantly-changing product sample, according to the Minute Maid Corp., Plymouth, Florida. The unit, which has been in successful operation for a year at this company's Leesburg plant, provides a measuring system that is continuous, automatic and accurate. Described in *Food Engineering*, the system is said to offer an improvement over standard hydrometer or refractometer density-measurements.

Effect of temperature change on the system is negligible. It prevents product dilution and fermentation, and can be regulated to discharge viscous liquids within a wide range of densities in an operation which saves time.

The diaphragm controller—fitted at the

base of a vertical column in such a manner as to dead-end a nozzle placed at right-angles to the column—pumps a small stream of molasses into the column base. An overflow fountain at the top of the column holds the liquid level constant. Density measurement is obtained through balancing the liquid column weight on one side of the diaphragm with air pressure on the other side. The fluctuations in diaphragm air pressure are relayed to a pneumatic controller that regulates the product flow with a throttle valve.

Positioned by the weight of the liquid in the column, the diaphragm relays to the controller an air pressure proportional to its deflection from standard position. Such air pressure is transferred by a linkage from the diaphragm to an air bleeder valve located on the reverse side, which relays the amount to the controller and exhausts any unneeded portion.

New Books

The New 'Chemical Industries'

THE 23rd edition of 'Chemical Industries,' just published, presents clearly a wealth of data concerning chemical plant and chemical engineering practice.

When first published nearly 30 years ago as the 'Chemical Engineering and Chemical Catalogue,' the book was the result of co-operation by some 120 firms, and provided nearly 400 pages of matter which was very fully indexed and cross-indexed. At this time the first of the standards adopted by the B.S.I. applicable to chemical industries were included, and also a bibliography of literature appropriate to the processes covered by firms using catalogue space.

Initially the book was edited by Prof. D. M. Newitt, F.R.S., but after the 16th edition pressure of other work caused him to relinquish the editorial chair.

In 1943, despite war conditions, the intention to remodel and widen the scope of the work was largely achieved, when the book was divided into ten sections, made up of 24 sub-sections. The glossary of industrial chemicals was increased by more than 50%. The new features included the glossaries of metals and alloys, non-metallic materials (and many tables dealing with metals and other structural materials), chemical plant and instruments. New glossaries of pharmaceuticals and perfumery raw materials (now including synthetics) replaced the less comprehensive glossaries of the 1942 edition.

During the next five years the book was substantially enlarged, many of the sections being revised or completely rewritten. In the 21st edition the scope of the book was further widened by the introduction of separate sections dealing with fuels, power production and transmission, and water treatment.

The next edition was completely revised and checked, and a major new section on refrigeration added. The tables have been rearranged for added convenience, and the index to technical data has been completely rewritten. This now lists about 4,500 references and cross-references; the 2,000 chemicals listed in the data of organic and inorganic compounds are not of necessity included in this figure.

The classified index has been substantially enlarged and appears in two sub-sections: 'Chemicals' and 'Plant.' The number of trade names and marks has greatly increased.

The editorial sections have clearly, therefore, been growing steadily in volume and in value over the years. The present volume measures 8½ in. × 11 in. and numbers 440 pages. The glossary and catalogue sections are fully illustrated with photographs and diagrams.

'Chemical Industries' is published by Leonard Hill Ltd., Stratford House, 9 Eden Street, London, N.W.1. The price is 30s. net.

Chemical engineering techniques

The concept of unit operations introduced some 30 years ago has occupied a predominant place in the teaching of chemical engineering both in this country and in America. This concept provided a method of examining chemical plants not from the aspect of industrial chemistry but from the outlook of the physical changes taking place. This form of examination has been very successful, but there is a danger that the treatment may be so sharply defined that the unit operations become ends in themselves and not, as the present authors so rightly say in their preface, a means to an end. It is the main purpose of this work* 'to point out the basic objectives of chemical engineering and to present the more important techniques now available for reaching them.'

These techniques are grouped on a functional basis in six sections: the assembly of materials, the preparation of materials for reaction; the production and distribution of energy; conditions affecting the chemical reaction; the separation and purification of materials; and the further treatment of products for sale, shipment, storage or other use.

The subject matter is rather unevenly presented, for, while the section on preparation of materials for reaction includes chapters on size reduction and classification which are comparable in length with those found in general texts on chemical engineering, the section on separation of materials is relatively short. This section is not much more than a list of possible methods for such separations as solid from solid, solid from liquid, etc., and the authors fail to indicate the relative importance or engineering cost.

It is doubtful if the photographs are adequate to enable the un-informed to appreciate the engineering size or complexity of the various equipments described, yet this is surely vital in assessing techniques. While much of the material is useful in showing the wide range of problems of the chemical industry, the book is rather too long and therefore expensive to serve as an ancillary work for the chemical engineering student in this country. J. M. COULSON, M.A., PH.D.

**Chemical Engineering Techniques*, by B. E. Lauer and R. F. Heckman. Reinhold, and Chapman and Hall, 1952. Pp. 496 inc. index. Illustrated. 48s. net.

Thermal diffusion

Thermal diffusion is the term applied to a relative motion of the components of a mixture caused by differences of temperature within it. First discovered in liquids, it was predicted in gases before being experimentally confirmed. In 1938, it was used to separate components of a gas mixture and in this way the isotopes of various elements were separated. The magnitude of the effect is strongly dependent on the nature of the forces exerted by one molecule on another, so that the study of thermal diffusion is one of the best means of investigating these forces. This aspect of the study is the one most fully dealt with in the present monograph.* The first five chapters give an introduction to the theory and an account of experimental methods. Then the related phenomenon, the thermo-effect of diffusion, is treated, followed by a description of the application of thermal diffusion to the separation of components of gas mixtures, and finally an account of its application in liquids.

**Thermal Diffusion in Gases*, by K. E. Grew and T. L. Ibbs. Cambridge University Press, 1952. Pp. 143, including index. 22s. 6d. net.

Unit processes

This is an established chemical engineering textbook* in which chemical manufacture is described in terms of unit processes—nitration, halogenation, sulphonation, oxidation, esterification, hydrolysis, polymerisation, etc. A number of specialists have collaborated to write the 14 chapters, each of which deals with a particular unit process. This new edition follows the general plan of its predecessors in its admirable emphasis on fundamental principles, with discussions of manufacturing processes introduced only to serve this end. Each chapter has been extensively revised in the light of new information in the technical and patent literature. There is a new chapter on the Oxo reaction, a greater stress on the synthesis of aliphatics, particularly from petroleum and natural gas, new flow diagrams, and more consideration of the economics of manufacture. 'Groggins' is a book that will improve any chemical library.

**Unit Processes in Organic Synthesis*, by P. H. Groggins, Editor-in-Chief. 4th Edition. McGraw-Hill. Pp. 937. 106s. 6d. net.

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Plant and Equipment

Automatic air driers

A new range of automatic air driers, the initial cost of which, it is claimed, is lower than for any other type of similar capacity, has been introduced by Burnett & Lewis Ltd. The main application of the Type DS *Humidryers* is for the continuous drying of instrument air and other gases to dewpoints as low as -40°F . The entire equipment operates under one pressure and reactivation of the adsorbent is carried out by split stream entering air, pre-heated to ensure complete heat transfer throughout the desiccant and the maximum efficiency of reactivation. Steam or electrically reactivated models are available, the former being advantageous for hazardous locations. All reactivation air is recovered and dried to the exit dewpoint desired; therefore, there is no loss of air. Since no external air stream is required for reactivation, contamination is impossible; this is an important point in drying gases where purity is vital.

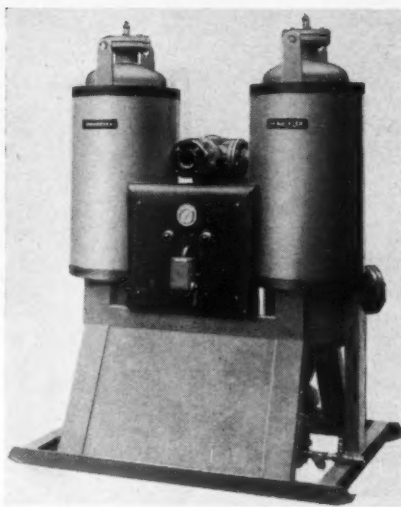
The unit incorporates two adsorber towers filled with activated alumina, so that drying is continuous, one of the towers being in service while the other is heated to remove previously adsorbed water. The adsorber towers are reversed, heated and cooled without manual attention, and the only moving part of the unit is the valve reversing mechanism which works only a few seconds at the end of each cycle.

To meet the needs of the smaller user the same manufacturers are also building a range of smaller, fully automatic driers, operating on an entirely different principle and known as Type PR. The essential simplicity of their construction enables them to be sold at a reasonable price. The Types PR and DS *Humidryers* cover flows from 1 s.c.f.m. up to 3,000 s.c.f.m. and pressures up to 200 p.s.i.g. Models outside this range are built to customers' requirements.

Humidity measurement and control

The *Humicon* electronic humidity measuring and control instrument was designed to meet an Inter-Service specification which included certain requirements that were not met by other types of humidity controllers. W. H. Sanders (Electronics) Ltd. have now been granted a licence to manufacture and supply this instrument to other users.

The *Humicon* is capable of working over a temperature range of 0 to 90°C . and has a good cyclic performance; that is to say, although the atmospheric conditions may vary very extensively, it always operates at the same point. The unit is fully tropicalised and both the control unit and detector head are imper-

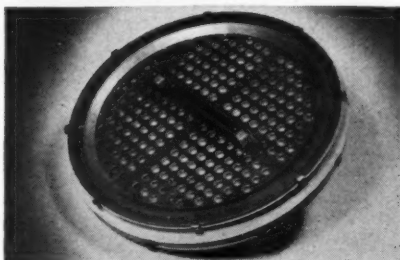
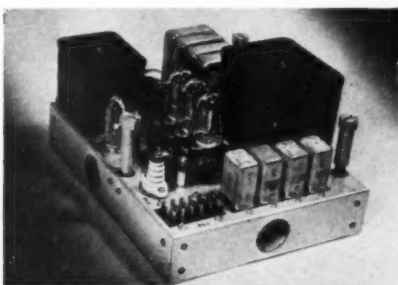


Type DS 'Humidryer,' model B (steam reactivated).

vious to insects and fungi. The humidity range over which control is possible is from 42 to 100%.

The detector head is approximately 6 in. diam. by 1 in. deep. This size has been chosen to enable the head to be in use for a very long time without cleaning and to make it react to very low air speeds. The detector head itself may be a considerable distance away from the control unit, provided that a low-capacity connecting cable is used.

It is possible to have several detector heads feeding into one unit. The heads would, of course, be switched into circuit at pre-set time intervals.



Above: Electronic humidity control unit.
Below: Detector head of the instrument.

A switch can be provided to enable different humidity settings to be selected.

This instrument has a high speed of operation and an accuracy of 10% is obtainable.

The *Humicon* control system can be linked to work in conjunction with a temperature control system.

The instrument is operated from 200 to 250 volts, 50 cycles, a.c. Approximate power consumption is 12 watts.

Ultrasonic flaw detector for pressure vessels

Ultrasonic flaw detection, introduced during the war, is now well established and additions to its already wide range of applications are continuously being made. Kelvin & Hughes (Industrial) Ltd., who were pioneers in this field, have now introduced a new ultrasonic flaw detector to be known as the Mark 5. It is designed specifically for the inspection of welded pressure vessels where the equipment must be passed through a manhole. The equipment, which is totally self-contained, measures 17 in. \times 9 in. \times 5 in. and has a total weight of less than 30 lb.

The advanced design of the new flaw detector includes the following novel features:

The scale can be expanded so that the width of the screen represents only a small part of the total range, thus facilitating thickness measurement or the individual detection of closely grouped flaws.

A very bright trace even on the shortest range is achieved and is adequate for daylight viewing.

The instrument, which uses the new lightweight leads, can be operated with the full range of Kelvin Hughes probes. A special combined transceiver probe provides many of the advantages of the dual probe system whilst allowing the ease of handling inherent in a single probe.

The co-axial sockets are duplicated to allow for use of special filters on a depth and thickness gauge.

The cathode ray tube and all valves used in this new equipment are easily obtainable standard types.

A handle on the front panel for carrying the instruments in a vertical position also gives protection to the controls.

An edge illuminated *Perspex* screen with an engraved scale facilitates photographic recording, for which a special camera can be provided.

The standard instrument operates from 200 to 250 volts, 50 c.s., a.c. mains. Other voltage ranges can be supplied on special order.

The principle of operation is as follows: As the C.R.T. spot passes the zero mark on the scale a pulse of ultrasonic energy in the form of a narrow beam is directed into the specimen under test by means of the transmitting crystal mounted in an exploring probe. Energy reflected, for example by the boundary of the specimen, is picked

up by the receiver crystal and causes a vertical deflection of the C.R.T. spot. The presence of a flaw is indicated by any deflection of the spot between the zero mark and the boundary echo. The position of the flaw in relation to the depth of the specimen can be deduced from the relative positions of the flaw echo and the boundary echo. By making use of the scale expansion feature, any part of the trace may be selected and expanded so as to allow detailed examination of the echo.

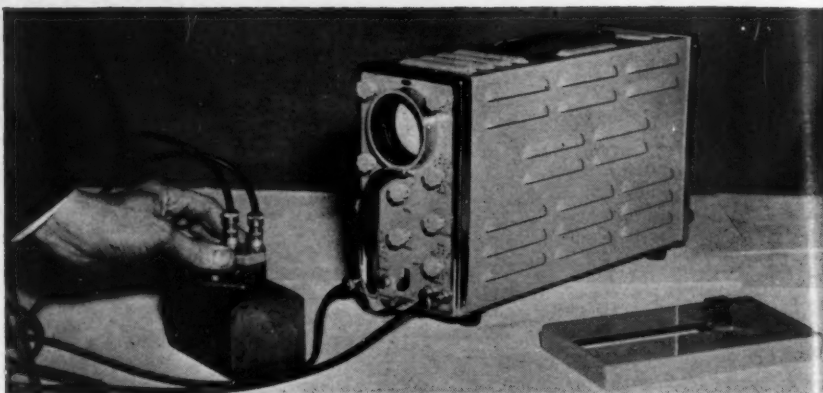
The operating frequencies are chosen to suit the type of material being tested and are selected by means of a switch. Frequencies available are $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$ and 5 mc.; intermediate frequencies can be obtained, if required, by the use of plug-in filters. The range represented by full deflection of the time base can be varied from 2 in. to 12 ft. when using the ordinary vertical probes. These distances are approximately halved when transverse wave probes are used.

Dust and fume extraction

The *Tornado* bifurcated fan unit mechanically exhausts dust- or fume-laden air or gases. Obnoxious, corrosive or inflammable gases may be dealt with at reasonably high temperatures.

The main feature of the unit is that the fan casing is split or bifurcated across a diameter and opened out to provide a separate chamber for housing the driving motor, thus isolating it from the fumes passing along the duct which surrounds it. Further, as the motor housing is open to atmosphere, the motor may work in a reasonably low ambient temperature with quite high temperatures in the surrounding duct; it is also readily accessible. Should it be necessary or desirable to remove the fan and motor at any time for repairs or maintenance the casing may be repositioned temporarily without these working parts and so, in many cases, enable the plant to continue working by means of natural draught, though at reduced efficacy, until the fan and motor can be re-installed.

This fan unit may be installed with minimum alteration to existing pipelines. It is simply installed, air or gas flowing straight through the unit co-axial with the pipeline, of which it forms an integral part, and it may be erected vertically, horizontally or at any angle with the fan discharging the air over the motor chamber. For general dust or fume applications the standard range of units incorporate a fan impeller cast in one piece in silicon-aluminium alloy. For additional protection against corrosive action the impellers may be anodised or painted. For more drastic corrosive conditions the standard impellers may be rubber covered or an alternative design of impeller incorporated with cast-iron centre and blades of special bonded plastic sheet. The characteristics of the fan impeller are such that the motor will not overload under any application



Ultrasonic flaw detector designed specifically for testing pressure vessels.

within the maximum capacity for the volumetric output.

Standard units are available in four sizes, 10 in., 12 in., 14 in. and 16 in. They are designed for temperatures of up to 150°F. in the duct. Special fittings for use at higher temperatures and fans for larger capacities than those dealt with by the standard units can be supplied.

The makers are Keith Blackman Ltd.

Electronic weighing machines for automatic control

An interesting example of the use of electronics to provide automatic control of the flow of materials is afforded by the installation at the Heysham Works of I.C.I. Ltd. of two constant-weight feeder equipments. The machines were built by Richard Simon & Sons, Nottingham, and are controlled by electronic gear supplied by the General Electric Co. Ltd. Each equipment provides a closely-regulated flow of approximately 10 tons/hr. of powdered limestone which is used in connection with a continuous chemical process. Any desired rate of flow over a range of $3\frac{1}{2}$ to 1 in weight can be selected by means of a calibrated control knob, and this flow is then automatically maintained by the equipment without further attention from the operator.

The method of operation is as follows. Powdered limestone from the preceding stage of the plant is fed into a hopper, and is loaded on to a conveyor belt by means of a motor-driven screw located in the base of the hopper. The centre portion of the loaded belt passes over a roller which is linked mechanically to a sensitive weighing mechanism housed in a container located above the belt, and two sets of contacts mounted on the weighing mechanism are employed to give signals to the electronic control gear when the loaded belt is too heavy or too light. The screw speed is then automatically adjusted until the balance of the weighing machine is restored, so that a constant flow of limestone is maintained for a constant speed of the conveyor belt.

The Simon constant-weight feeders are

designed to deliver a continuous flow of material at any desired rate/hr., irrespective of any alterations in the bulk density or changes in the ability of the material to flow.

The setting of these feeders for a given throughput is very simple. After placing the required weights on the weighing beam, the operator presets the flow rate by setting the band conveyor speed controller until the required speed is shown on the tachometer dial. A conversion scale is provided to indicate the rate of flow in tons/hr.

The constant-weight feeders embody a patented feature which consists of a simple automatic two-rate correction control. Thus if a large change takes place in the bulk density of the material, a continuous correction is applied to the feed control unit until the feed rate is correct. The weighing unit will then apply corrections in small increments only, thus preventing hunting. Pilot lamps are incorporated so that the operator can see at a glance which correction is being applied to the feed rate. The machine is also fitted with a cut-off switch which sounds an alarm when there is no material above the feed inlet. The feeders also record the amount of material which has been delivered.

The complete control gear for each of the equipments is housed in ventilated cubicles of sheet steel construction mounted side by side in a pressurised control room.

Both machines are separately excited, the D.C. supplies for the field circuits being obtained by means of metal rectifiers and the supplies for the armatures from thyatron rectifiers. A three-phase bank of thyratrons is used for the supply of the screw motor and a two-phase bank for the conveyor motor; apart from this feature the electronic control circuits of the two motors are similar.

For the control of each motor an adjustable 'speed setting' reference voltage is provided. The speed setting of the band conveyor is adjusted manually and, in the case of the screw feed motor, a pilot motor is used to vary the speed setting in accordance with the signals

from the contacts on the sensitive weighing mechanism.

In each case the reference voltage is compared with the voltage across the armature of the motor, and the difference voltage is then amplified and is supplied to the control grids of the thyatron rectifier. The output voltage of the rectifier, *i.e.* the voltage applied to the armature, is consequently varied to match the voltage selected by the speed setter.

To protect the thyratrons from overloads a limiting circuit is included which prevents the armature current from exceeding a predetermined value. If the motor is stalled, the current will remain at the limiting value for 30 sec., after which a thermal overload trip will open the armature contactor.

The fall in motor speed as the mechanical load is increased is corrected by a compensating circuit which increases the voltage applied to the armature in proportion to the increase in armature current.

Small sifting machine

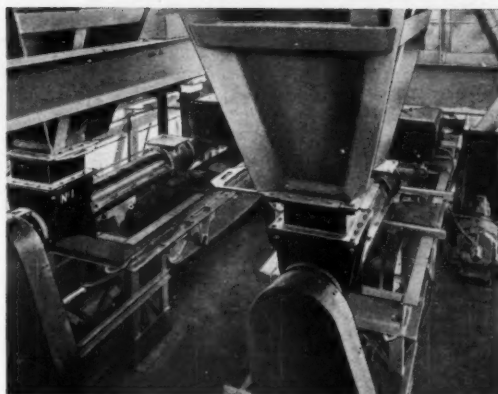
Designed to meet the need for a small, flexible, dust-proof sifting machine for screening and grading powdered or finely granulated materials at what are claimed to be economic rates of throughput, the Simon Junior Sifter has been developed by Henry Simon Ltd., of Stockport.

The eight sieves in this machine are enclosed in a steel case suspended by canes from a steel frame, and driven through an eccentric mechanism mounted on the frame beneath the case. The sifting covers are attached to wooden frames, of uniform size so that they can easily be interchanged, and the frames are fitted into 'drawer-type' trays of non-corroding aluminium alloy. The trays are fitted with fabric cleaners. The clothing of the sieves can be of wire, silk or nylon bolting cloth, according to the type of material being treated. It is possible to arrange the sieve trays in any one of three different schemes in order to make different separations. The sieves are housed in two sections of four trays each, and one or two inlets and two, three or four outlets are available, according to the scheme chosen.

The machine normally requires a motor of only $\frac{1}{4}$ h.p.

Constant-rate feed scale

A new electronic scale to supply a constant flow of material in lb. hr. has been produced by W. & T. Avery Ltd. This machine represents an advance in the mechanisation of industrial weighing. Instead of having to weigh individual quantities by hand, materials can be fed in at one end, and the scale ensures that the correct weight flows out at the other.



The G.E.C. constant-weight feeder equipment at the Heysham works of I.C.I. Ltd.

Once it has been set, the machine is self-correcting.

The constant-rate feed scale is designed particularly for the non-stop mixing and blending of granular-type materials—chemicals, baking ingredients, powders, etc.

A blanket of material is supplied to a moving belt and balanced on a weigh beam. As long as the correct weight is flowing along the belt the feed stays constant. If there is an error of only 3 drachms, an electronic switch fitted to the scale alters the feed to correct the error.

A very wide range, in lb./hr., can be covered by altering the weights in the weight box, and by choice of belt speed.

Plastic replaces lead and brick-lined tanks

Using one of its own plastics, *Laminac* polyester resin, reinforced with *Fiberglas* mat, American Cyanamid Co. has replaced the lead- and brick-lined steel tanks it formerly used in the manufacture of alum with three major advantages: a cost of approximately \$6,500 *v.* \$14,000; a weight of 2,200 lb. *v.* 13,200; and a longer life in use, without the danger of product contamination from corroding, chipping brick.

The tanks are used at the company's Mobile, Alabama, plant and serve to evaporate to dryness an aluminium sulphate liquor whose pH of 3 makes it a very corrosive agent. The process, carried out at temperatures that range from 160 to 242°F., takes approximately 4 hr. The charge for each cycle is 4,000 gal., which weigh 20 tons; the high strength-weight ratio of the reinforced plastic made it possible to build the tank with a side-wall thickness of only $\frac{3}{8}$ in. and a bottom thickness of only $\frac{1}{2}$ in. The tanks are 8 ft. high and 14 $\frac{1}{2}$ ft. in diameter and are equipped with stacks (also fabricated from reinforced *Laminac*) that are 22 ft. high and 30 in. in diameter.

The one-piece moulded tank was fabricated for Cyanamid by Beetle Plastics Corp., using the plastic mentioned as being the type which has shown the best chemical

resistance of the polyester resins. Because it can be formed with little or no heat or pressure, the plastic lends itself very readily to the production of large structural parts, such as these tanks. Another interesting development is a similar tank, moulded in sections for easy transportability and erection on the site, which is now available.

Electronic computer for process control

Remington Rand Inc. has developed an electronic computer called 'Era 1103,' which makes it possible to apply automatic processing to a large oil refinery or chemical plant, among other uses.

It is described as a new ultra-high-speed general purpose electronic digital computing system. The device provides storage capacity up to 17,408 super-speed registers plus unlimited supplementary magnetic tape bulk storage and high operating speed. The first commercial models will be available for delivery next year.

Reduction gears

A $1\frac{1}{2}$ double reduction unit, designed to transmit very small horsepowers at low speeds, has been developed by David Brown Gears (London) Ltd., from their $1\frac{1}{2}$ and $1\frac{1}{2}$ single *Radicon* worm reducers. These units have many component parts interchangeable with those of the single reduction types. By utilising the standard worms and wormwheels of the $1\frac{1}{2}$ and $1\frac{1}{2}$ single reducers, a wide variety of output speeds is achieved, with standard ratios ranging from 65:1 to 3,600:1. Units with non-standard ratios up to 10,000:1 reduction are also available.

Reductions varying from approximately 5:1 to 60:1 are obtained with each pair of worm gears, and input speeds range from 500 to 3,000 r.p.m. All gears in the standard units are right hand, giving the same direction of rotation of both input and output shafts. Four shaft handing arrangements are available, and units giving opposite rotation of the shafts can be supplied if required.

Equipped with detachable feet for mounting in alternative operating position, the double reduction units can be fitted directly to the motor by means of adaptors, which are integral with the wormshaft end covers. These standard adaptors cover all makes of fractional horsepower motors.

When lubricated and running at a maximum temperature rise of 100°F., units will carry a momentary overload of 100% on starting. It is important to ascertain accurately the actual power to be transmitted and its duration. If the working period is less than the time taken to reach maximum temperature, a heavier loading is often possible.

The case is of cast iron and provides ample surfaces for cooling by natural convection.

Vermiculite, a Versatile Mineral

IN a new booklet* E. R. Varley comprehensively describes the history, properties, sources, uses and production of vermiculite, a material for which many industrial uses have been developed during the past 25 years.

The name is applied commercially to a whole group of platy, laminated minerals, resembling and being easily mistaken for mica. They range in colour from black through various shades of brown to yellow. Compared with mica, vermiculite is generally drab, soft and flaccid, without transparency or resilience and possessing a somewhat soapy or talcose feel. Its most striking and entirely individual property, however, is that of exfoliation. This is a bloating effect, which takes place whenever heat is applied. The crystals then expand in the direction perpendicular to the laminae and a plate of vermiculite may swell to some 20 times its original thickness in a manner resembling the opening out of a concertina. Expansion is between 12 to 18 times the original thickness in American samples of commercial grade, 24 times with best Australian material and, on average, 26 times with South African vermiculite. A freak expansion to 30 times the original thickness has been recorded with a South Carolina sample.

Exfoliation commences at different temperatures according to the type of vermiculite, sometimes as low as 150°C. Industrially temperatures between 800 and 1,110°C. are applied for between 4 sec. and 2 min. The development of golden bronzy or silvery lustres is another certain characteristic of vermiculite. A lighted match or cigarette applied to a thin edge of the mineral will produce both these effects, thus making field tests simple.

The author describes how in 1824, T. H. Webb first gave the name 'vermiculite' to a mineral occurring at Milbury, Worcester, Massachusetts, because of its property of developing long worm-like threads on heating. The name is, in fact, derived from the Latin *vermiculari*, 'to breed worms.' Today there is a recognised true vermiculite with a characteristic crystal lattice structure, consisting of the interleaving of molecules of water with biotite- or talc-like silicate layers. However, many similar minerals are known generally as vermiculites. These are all monoclinic, hydrated, ferro-magnesian aluminosilicates and, in commercial practice, the term covers any minerals of this type with exfoliating properties of possible industrial application.

Although described so long ago, vermiculite was not used industrially until about 1921 and only in 1925 did it appear on the market in any considerable quantity.

The mineral was first described and then

exploited commercially in the United States. Today, production and use are greater in that country than anywhere else. Most of the economic deposits are in Colorado, Montana, Nevada, North Carolina, South Carolina, Texas and Wyoming, with others in Arizona, Maryland, Massachusetts, Oregon, Pennsylvania and Utah. Montana usually provides 90% of the total output. Demand is so high that large quantities of South African vermiculite have been imported since 1945. Since 1924 over 1,000,000 tons of material worth rather more than \$10,000,000 have been produced. Annual production for the latest year for which figures are available was 208,096 tons.

In South Africa, recorded output began in 1938 and has greatly expanded in recent years until in 1950 it was over 40,000 long tons.

Vermiculite is found in Australia in Queensland, South Australia, Tasmania and Western Australia, but has only been produced consistently in the last-named State. Production in 1950 was 120 tons, but this is less than in some other years. Total production between 1939 and 1950 was 1,740 tons.

Deposits of the mineral are found in many other countries. Exploitation is planned in Kenya, Canada and in Portuguese East Africa, and the mineral is being produced extensively in Russia, and in smaller quantities in Argentina, Southern Rhodesia, Tanganyika and Uganda. Deposits are also found in India, Europe, parts of central Africa, Sierra Leone, South-West Africa, Madagascar, South America, Burma and Japan. Some of these are promising. Most others are of poor quality or too far from any transport system for mining to be economic.

Uses

Although much of the booklet is necessarily devoted to the distribution of the mineral, the author also gives full details of its uses. Vermiculite is mainly employed for insulating purposes and as an aggregate in the making of lightweight concrete. For some years this has been its principal application, but many others are now being developed. They include the production of a pure form of flake silica by leaching with sulphuric acid, almost the only instance in which unexfoliated vermiculite is used. The mineral has also been employed on the electrolyte in galvanising baths, in the manufacture of sealing compounds and plastic emulsions, as an insecticide carrier, and as a packing material, in plastics, as a catalyst substrate, in enamel, in oil refining, as a filter aid, in gas or liquid phase chemical processes, as a filling for dust filters and absorption towers, as a support for seedlings in hydroponics and in other agricultural and horticultural uses, these last having been con-

siderably developed in the United Kingdom, Southern Rhodesia and the United States.

There are no well-defined grades of quality of vermiculite, since, as the report points out, chemical composition is little criterion of quality and it is not usually easy to determine the mechanical, thermal, acoustic and electrical properties of the mineral. Quality can only be satisfactorily determined by a technical trial, degree of exfoliation, mechanical strength and possibly size of flake and colour being main considerations. Size grading is important, as the optimum particle size varies with different uses. In 1951, the price of screened and cleaned vermiculite in the United States was about \$12 to \$14 per short ton f.o.b. In 1950, the local sales and exports price of South African vermiculite was £6 2s. per long ton f.o.b., while the average price for the Australian product in 1949 was £4 16s. per long ton.

It is pointed out that, although vermiculite is expensive, its uses, particularly in the building industry, results in a saving in the cost of other materials.

Styrene survey

Prepared by the manager of the Plastics Division and the director of the Physical Research Laboratory of the Dow Chemical Co., this monograph* is largely based on work done by the firm. It claims to be the first complete survey of its subject ever published and to give a thorough account of the polymerisation, copolymerisation, chemical modification and manufacture of styrene and its commercially useful derivatives.

The book opens with a historical account of styrene. Its discovery is usually credited to Simon in 1839, but the authors consider that there is evidence to show that it was actually discovered by William Nicholson in 1786 and only named by Simon at a later date.

The historical account is followed by a description of current methods of manufacture and chapters on physical properties, methods of handling and analysis and chemistry. The theory and practice of styrene polymerisation are then discussed, together with the uses of styrene monomer, with particular reference to synthetic rubber. The rest of the book covers the physical behaviour of polystyrene, styrene derivatives and resins, German styrene practice, copolymers of styrene and the fabrication of polystyrene.

An appendix deals with recent advances, including vinyltoluene, a material similar to styrene which uses toluene as a raw material, thus saving benzene, which has been in short supply.

**Styrene: Its Polymers, Copolymers and Derivatives*. Edited by R. H. Boundy and R. F. Boyer. American Chemical Society Monograph Series. Chapman & Hall, 1952. Pp. 1304 including indexes. 160s. net.

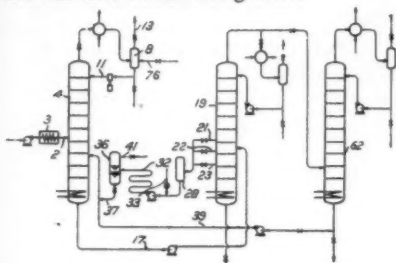
**Vermiculite*, Colonial Geological Surveys, Mineral Resources Division, by E. R. Varley. H.M.S.O., London, 1952. Pp. 70 including indices. 7s. 6d. net.

Chemical Engineering Invention

MONTHLY SUMMARY OF PATENT CLAIMS

Purifying crude ketones by distillation

Crude ketone containing secondary alcohol, aldehydic material, water and hydrocarbons having higher boiling points than the ketone is fed into a fractionation zone. The aldehydic material is either withdrawn as vapour or converted into higher boiling compounds by introducing a suitable reagent. The bottoms from the fractionating zone are passed to a second fractionating zone from which a liquid side stream is withdrawn from a point where the concentration of hydrocarbons is high. Substantially pure ketone vapours are withdrawn overhead and aqueous alcohol is withdrawn at the base. The side stream is scrubbed with water and the hydrocarbons are then separated from the aqueous solution of ketone and alcohol so obtained. This aqueous solution is passed into the first fractionating zone.



The process is applicable to the purification of acetone, methyl ethyl ketone, mesityl oxide, acetonyl acetone, cyclohexanone and acetophenone. Such a process is particularly useful in removing olefine-polymers, formed by undesirable side reactions in the dehydrogenation of secondary alcohols, from the crude ketone.

Crude acetone containing 0.02% aldehydes and 0.19% hydrocarbons, obtained by the oxidation of isopropanol, is passed through heat-exchanger 3 and line 2 into column 4 which contains 30 to 40 bubble trays. Acetone vapours containing 2.4% aldehydes and 6% hydrocarbons are withdrawn from the head of the column and condensed. The condensate is partly eliminated from the system and partly returned as reflux to the column. The liquid withdrawn from the base of column 4 contains 0.2% hydrocarbon-polymers, and is passed through line 17 into column 19 which contains 35 to 45 bubble trays. Liquid amounting to 0.2 to 0.3 of the charge to column 19 is continuously withdrawn from the zone of high polymer concentration therein, by means of one or more lines 21, 22, 23. This liquid is passed into accumulator 28 and is then forced, together with water introduced at line 33, through mixing-coil 32. The mixture is allowed to separate in chamber

36; the polymer is eliminated from the system through line 41, and the aqueous layer is passed to column 4 via lines 37 and 39. The heads from column 19, which contain 99.6% acetone, may either be condensed and, except for reflux, eliminated from the system, or they may be still further purified in column 62. Aqueous isopropyl alcohol is withdrawn from the base of column 19. A dilute solution of sodium hypochlorite or other alkali hypohalite, in an amount not substantially in excess of that equivalent to the aldehydic material, may be added through line 76 into accumulator 8 at the head of column 4. In this case the reaction mixture is passed into column 4 through line 11 and light hydrocarbons are vented through line 13. The reaction products are eliminated from the system at the base of column 19 (salts) and also through line 41 (chloroform). Specification 392,652 is referred to. —640,581, *N/V de Bataafsche Petroleum Maatschappij*.

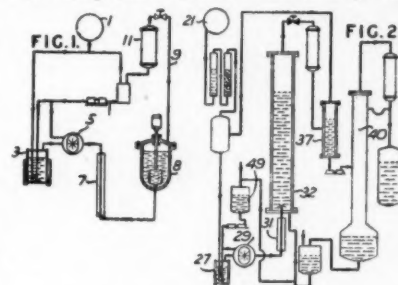
Safe handling of acetylene

In processes involving the handling of acetylene at temperatures and pressures at which it is normally explosive, the danger of explosion is eliminated by contacting the acetylene, while still under non-explosive conditions, with a volatile normally-liquid organic compound which is non-explosive under the conditions of handling. The compound is maintained at a predetermined temperature in the liquid phase, so that the ratio of acetylene to vapour taken up is also predetermined, and such a mixture is non-explosive when raised to the temperature and pressure at which it is to be handled. The mixture is then compressed at a temperature above that at which the vapours will be condensed and, if necessary, finally brought to the desired temperature at which it is to be handled. The process is normally applicable to chemical reactions involving acetylene, when the liquid organic compound may be the other reactant or the product of reaction, if these materials have a suitable vapour pressure. Otherwise, an inert diluent may be used, such as compounds consisting of hydrocarbons, esters, ethers, furfural and pyridine.

Fig. 1 shows apparatus suitable for batch processes. Acetylene at a low pressure (about atmospheric) is led from the holder 1 to the carburetter 3, held at a predetermined temperature, where the desired amount of the vapour of the organic liquid is taken up. The compressor 5 brings the pressure up to that necessary for the reaction, the temperature of the compressor being sufficiently high to prevent condensation of the vapour therein. The gaseous mixture is brought to the

reaction temperature in the preheater 7 and introduced into the autoclave 8 where the reaction takes place. If the diluent has a vapour pressure greater than the reaction pressure, it is continuously run off through line 9, condensed in the condenser 11 and returned to the carburetter 3. If the product of the reaction is used as diluent, only a portion thereof is so used, the remainder being retained in the autoclave.

Fig. 2 shows the application to a continuous process. Acetylene from a holder 21 passes through carburetter 27, compressor 29 and preheater 31 as before, and enters the reaction tower 32. The liquid products are separated from acetylene in the degasser 37 and are separated into diluent and reaction product in the still 40. If the reaction product is used as diluent, the still 40 serves to withdraw a certain portion thereof to the tank 49 for



re-use. In each case, the unreacted acetylene is withdrawn from the reaction zone and recycled, the pressure being reduced to the safe value for acetylene alone before it is separated from the vapour of the organic liquid. Suitable types of carburetter for both types of process are illustrated.

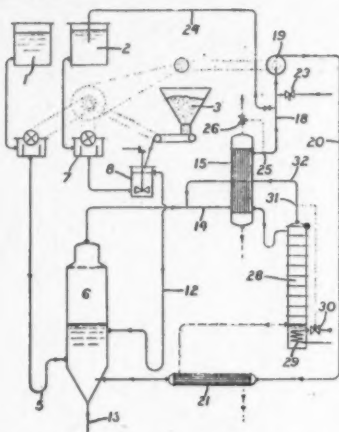
The process of the invention may be applied to any chemical reaction involving acetylene, e.g. production of mono-vinyl-acetylene, of vinyl chloride and of acetaldehyde by the mercury process, but the reactions with secondary amines to give N-vinyl compounds and with carboxylic acids to give esters are excluded, these forming the subjects of Specifications 641,437 and 641,438 respectively. The specification is particularly concerned with the reaction of acetylene with hydroxy compounds (especially lower aliphatic alcohols) to yield vinyl ethers. The hydroxy compounds may be represented by the formula $X.R.OH$, R being an aliphatic, hydro-aromatic or aromatic, preferably hydrocarbon radical or an aralkyl radical, X being $-H$, $-NY_2$ or $-(OR)_n$, $-OY$, Y being $-H$, $-R$ or $-R.OH$ and n being zero or an integer. Hydroxy-acids are, however, excluded, since they yield esters, not ethers. Detailed examples are given of the production of methyl vinyl ether,

ethyl vinyl ether and *n*-butyl vinyl ether using the apparatus shown in Fig. 2, and of *n*-octadecyl vinyl ether using that shown in Fig. 1. Suitable hydroxy compounds are mentioned, including aliphatic alcohols, glycols, polyhydroxy compounds and their alkyl and aryl ethers, amino-alcohols and phenols. Specification 427,036 is referred to.

The specification as open to inspection under Section 91 shows further types of carburetters where the acetylene is contacted with the diluent in the vapour phase instead of the liquid phase. The reaction between acetylene and hydroxy acids and their salts (e.g. alkali metal glycolates) is also mentioned, and the subject-matter of Specifications 641,437 and 641,438 as open to inspection under Section 91 is included. This subject-matter does not appear in the specification as accepted.—641,436, *General Aniline and Film Corporation*.

Diammonium phosphate production

Diammonium phosphate is made by continuously introducing phosphoric acid and ammonia gas into a reaction chamber in which a constant pressure is maintained. The ammonium phosphate is withdrawn and in the upper part of the chamber the mixture of steam and ammonia which is evolved is collected. From this the ammonia is separated by condensation and, if desired, by distillation, and recycled to the chamber after addition of fresh ammonia equal to the amount used in the reaction. The respective quantities of phosphoric acid and ammonia continuously introduced into the chamber are maintained constant. The partial pressure of ammonia gas in the chamber is sufficient to prevent decomposition of the diammonium phosphate formed.



As shown, phosphoric acid from vat 2 is supplied through a measuring device 7 and siphon 12 to a saturator 6 into which hot ammonia gas is passed from pipe 20 and the hot paste which is formed is withdrawn through pipe 13, granulated and dried. Steam, formed during the reaction, and ammonia pass through line 14 to a reflux condenser 15 from which

cold dry ammonia is discharged into pipe 18 and returned through compressor 19 and heat exchanger 21 to the saturator after addition of fresh ammonia through valve 23. Uncondensable gases are continuously purged through pipe 24, ammonia carried over being recovered in the phosphoric acid in vat 2. The slightly ammoniacal condensate from 15 is passed to a distillation column 28 from which ammoniacal vapour is returned through

pipes 32 and 14 to condenser 15. Exhausted liquor is discharged through line 32 and heat-exchanger 21. The circulation of cooling water in condenser 15 and admission of steam to heating coil 29 of the distillation column are automatically controlled by regulators 26 and 30 respectively in conjunction with respective pyrometers 25 and 31.—640,361, *Manufactures de Produits Chimiques du Nord Etablissements Kuhlmann*.

Plant for Perlon Manufacture

THE manufacture of synthetic fibres is of growing importance in the chemical world. The output of *Perlon* and other fully synthetic fibres is constantly increasing. Apart from the large chemical firms engaged in this work, textile firms are beginning to manufacture their own *Perlon* fibre—especially staple fibre—for mixing with other materials such as wool, cotton and rayons. *Perlon* staple fibre can easily be made in small quantities by textile works, the incidental expenses such as testing facilities being relatively low. The smallest economical plant for *Perlon* silk, on the other hand, would have a capacity of at least 10 cwt./day.

E. Tingley & Son Ltd. have built several complete *Perlon* plants, from the caprolactam stage to the finished fibre. Special pieces of plant and extensions to existing plants have been supplied to many other firms.

Development and construction work is now extending to the polymerisation of caprolactam for the batch production of *Perlon* silk and a continuous process for staple fibre. Equipment is also available for nitrogen purification (for the complete removal of oxygen), chip washing and drying, wash liquor evaporation, nozzle cleaning, etc. Nozzles, pumping gear and spinning heads of various types are also supplied. A new type of spinning head is undergoing its final tests, and promises to give trouble-free operation.

The two processes mentioned above are briefly as follows:

The older batch process consists of autoclaving caprolactam at 260 to 300°C. The molten mass is spun into ribbons, which are cut to chips after cooling. These are washed (to remove the remaining 8 to 10% of monomer), dried, and sent to the spinners where they are melted and spun into fibre.

In a more recent continuous process the polymerisation is conducted in the presence of a catalyst at atmospheric pressure. The remaining monomer cannot be removed so easily in this case, and the product is therefore suitable for staple fibre rather than continuous filament, although further work on this problem shows promise.

A high-temperature heat-exchange medium of the diphenyl type is generally used in the polymerisation, using the vapour phase for temperatures above

250°C. Higher boiling aryl silicates are also available, and ample experience has been obtained with both types of heating on batch and continuous processes.

A plant for producing 1 cwt./day of *Perlon* staple fibre costs between £3,700 and £4,100 and it comprises: one jacketed 45-gal. melting kettle; one jacketed filter; one jacketed 22-gal. stirred vessel; one vapour tube; one spinning head with two nozzle screw caps and pumps, but without nozzles; one nitric acid reservoir (suction-operated) for cleaning nozzles, pumps, etc.; one nozzle pre-heater; one water heater; one heater for (diphenyl) medium, liquid and vapour; one lactam feed-pump and drive; one nitrogen reservoir (for this plant it is more economical to buy nitrogen free from oxygen than to purify commercial nitrogen); and complete pipelines and fittings, including heater valves and pumps.

Chlorinated rubber paints have been in general use for some years and it is therefore surprising that their value, particularly in combating alkali, acid and severe corrosive conditions, is not as widely known as might be expected. To provide further information on their various properties and uses, M. W. Heilbrun, B.Sc., technical director of Allweather Paints Ltd., has written a comprehensive memorandum which is available from the company.

Mechanical stokers. Three brochures have been produced by Babcock & Wilcox Ltd., each describing one of the types of mechanical stokers made by the company. The three stokers described are: Style 6—a chain grate stoker for the small- and medium-size industrial boiler with natural or balanced draught; Style 133—a chain grate stoker for the medium-size industrial boiler; and Style 28—a travelling-grate stoker suitable for the largest boilers for which stoker firing is practicable, and for the more difficult fuels. Points of design, construction and performance are fully explained. It is pointed out that the entire performance of a stoker-fired boiler—efficiency, availability and even the actual life of the tubes—is directly dependent on its stoker. Stoker performance actually depends upon many conflicting conditions, none of which follows any simple straightforward law, and presents problems which are capable of solution only by ceaseless research and experiment.



'PORVIC' MANUFACTURE

The manufacture of 'Porvic' microporous plastic at the Dagenham factory of Pritchett & Gold & E.P.S. Ltd., was described in our April issue (page 94). Left: The plastic 'dough' is being taken from the mixer for subsequent extrusion. Right: Checking the dimensions of the finished sheets of 'Porvic' and examining them for flaws.

Magnesium made corrosion resistant

An American aircraft company which uses magnesium for many vital parts of aircraft has developed a method of treating it to offset this metal's tendency to corrode.

The magnesium parts are first degreased in a trichlorethylene degreaser, with vapour temperature maintained between 188 and 189°F. After degreasing, the parts move to an electrocleaning tank, where they are cleaned by a solution made up of 4 to 6 oz. of anodyne per gal. of water. The solution is kept at 185°F. In general, no current is used in this operation since the solution itself provides enough cleaning action. A hot rinse at 200°F. follows. After the two cleaning operations, the parts are inspected. They are then ready for the surface treatment.

According to *Industrial Finishing*, the surface treatment used is determined by the alloy. The company uses three processes, designed as Process Nos. 1, 2 and 3.

Process No. 1 is a chrome pickle solution made up of 1½ lb. sodium dichromate per gal. of water and 1½ pints of nitric acid per gal., and is used at room temperature. Since this process removes up to 0.0006 in. of metal, it cannot be used on high precision machined parts. It is recommended on magnesium parts containing aluminium, brass, bronze or steel inserts. For treating castings, a modified solution is used, 2 oz. per gal. of sodium fluoride being added to the regular charge.

With Process No. 2, a commercially available acid solution containing ammonium bifluoride as the active agent is used. The concentration is maintained at 6 to 6½ oz. of acid per gal. of water. Following this, and a rinse, the parts are immersed in a sodium dichromate solution at 212°F. containing 1 lb. sodium dichromate and ¾ oz. magnesium fluoride per gal. of water.

Process No. 3 is a sealed chrome pickle treatment and is a combination of the other two processes. In this case, drying may be omitted. The parts coming from the chrome pickle tank can be rinsed and then inserted immediately into the boiling sodium dichromate solution. In addition to surface passivation, this double treatment has a sealing action to the chemical coating and this greatly increases corrosion resistance.

Immediately after surface treatment, the parts are primed with a modification of conventional zinc chromate primer containing resin additives. A double coating is applied and allowed to dry. Next, for further protection, a finish coating of nitrocellulose lacquer or synthetic enamel is applied.

Recovery of copper from pickling sludge

Copper of high purity—of fine sponge-like texture, large surface area and high chemical activity—is being salvaged from waste pickling sludge of the brass and copper industries. The salvaged material appears to be a valuable gas or liquid-phase reaction catalyst. The salvaging method involved a displacement reaction and electrolysis process. The new method, described in *Industrial and Engineering Chemistry*, March 1952, may replace the electrodeposition and scrap-iron removal of copper from sludge and also recover a portion of zinc. In addition, it may eliminate the problem of disposing of acid pickling baths.

The physical characteristic of the copper formed in the displacement reaction is a sponge-like structure that is strong enough to support 25 times its own weight. Under greater weight, it crumbles to a fine powder. The first step in the displacement reaction involves removal of 70% of the acid from the sludge by vacuum filtration, followed

by a union of the remaining acid with the zinc and hydrogen. This union causes a turbid condition that acts as a physical force to separate the copper. The actual displacement of the copper is also dependent upon the presence of from 4 to 7% of sulphuric acid in the solution, and upon the degree to which the entire solution is agitated. The degree of agitation required to form a sponge-like copper of 99% purity involves passing the solution past the zinc at a rate slow enough to bring fresh solution in contact with the zinc and to form a fine cloud of evolving hydrogen. The hydrogen cloud helps to prevent the copper from disintegrating by a fast gas-bubble formation or by force of movement that is too rapid.

Production proportions can be illustrated by the fact that laboratory tests have produced a ¼-in. layer of copper sponge from 100 g. of 33% sludge solution with a zinc-reaction area of 10 sq. in.

Heat transfer from gas flames in water-cooled tubes

A study of conditions affecting the heat transfer from burning post-aerated town gas in a water-cooled tube has been made by M. E. Saleh and S. R. Tailby in the chemical engineering laboratories of Battersea Polytechnic, London. In a paper read before the Institution of Chemical Engineers in London recently the authors state that four variables have been studied. They were: the tube length L (ft.), gas pressure P (in w.g.), jet diameter f (in.), and the distance separating the gas jet from the lower end of the tube S (in.).

If Q = rate of air entrained in cu.ft./hr.
 $Q = 12L + 144P + (426 - 870P)f + 190$
 The percentage total efficiency (i.e. heat output as a proportion of gross C.V.) is given by:

$$\text{Per cent. total efficiency} = 6.64L + 23P + (1229 - 3280f - 139P)f + 0.34S - 92.$$

The percentage radiant efficiency based on the gross C.V. is given by:

$$\text{Per cent. radiant efficiency} = -10.7L + 23P + (1520 - 140P - 4920f + 18S) - 3S - 89.$$

The convection coefficient $h_{\text{conv.}}$ in B.Th.U. sq.ft./hr.°F. is given by:

$$h_{\text{conv.}} = 0.15L + 0.87P + 8f - 1.29.$$

For a 2-in. I.D. tube the use of a jet diameter of ⅜ in. for a 6-ft. tube, or ¼ in. for a 5-ft. tube or ⅜ in. for a 4-ft. tube is suggested.

Curves relating the variables have been obtained.

It has been shown that luminous radiation from the flame is of great importance, and the difficulty of providing a sufficiently long tube has to be overcome. One solution to the problem is the use of turbulence promoters to speed up the combustion reaction. Further work along these lines is proceeding.

World News

GREAT BRITAIN

Rock fibre industry for Scotland

The Cape Asbestos Co. Ltd., of London, who have world wide interests in asbestos products, have completed arrangements for the production of inorganic fibres from a natural rock, of which there are considerable deposits in Scotland.

William Kenyon & Sons Ltd., heat insulation engineers, rope and textile manufacturers, of Dukinfield, Cheshire, who have carried out extensive investigations into the manufacture and utilisation of this new product, will act as sole distributors of the material, which will be marketed under the registered trade name of *Rocksil*. The encouraging response to their initial approaches to a wide variety of markets has more than justified the decision to go into full scale commercial production.

It is claimed that the fibres made from this indigenous material have a silken appearance, possess a very high tensile strength, and the long staples when made up into the form of mats offer a high resistance to the transmission of heat, cold and sound. The fibres can be produced to almost any degree of fineness and, in mass, look almost pure white. They will withstand temperatures up to 1400°F. and will accordingly cover a very wide range of requirements in the heat insulation industry.

Factory premises and land have been acquired in the town of Stirling, which has been chosen because it is near the raw materials and to the Clyde and neighbouring shipbuilding industries which, it is expected, will become large users of the product.

Although somewhat similar fibres have been produced in this country for a long time, the manufacture of this type of long staple fibre from indigenous rock has never before been conducted on a commercial scale, so that this project is actually a new industry for Britain.

Another prominent newcomer to Scotland sponsored by Cape Asbestos is its subsidiary, Marinite Limited, which has acquired large factory premises at Germiston, Glasgow, where elaborate plant is being installed for the production of Marinite boarding for ship joiner work. This board is manufactured under a process initiated by the Johns-Manville Corporation in the U.S., where it is almost universally applied in the American shipbuilding industry. It is intended that in the manufacture of this product, other materials indigenous to Britain shall be utilised and in addition it is expected that substantial quantities of rock fibres will be used in conjunction with the Marinite boarding.

William Kenyon & Sons are also de-

veloping the diatomite deposits at Loch Cuithir on the Isle of Skye and are at present erecting factory buildings at Uig on the north west side of the island with a view to refining the material and rendering it suitable to meet a wide range of applications.

Chemical engineers' new factory

Stockdale Engineering Ltd., have moved from Manchester to a new factory in London Road South, Poynton, Cheshire. The increased facilities provided by this new factory will enable the ever-increasing volume of business to be handled more expeditiously. The new building has been designed by Benjamin Waterhouse, F.R.I.B.A., on modern lines with chalet characteristics derived from Swiss architecture.

Duty-free machinery imports

An independent committee has been set up to review the long-term problem of the duty-free entry of machinery into the U.K. This follows the statement by the Chancellor of the Exchequer in his Budget Speech in March last year that the issue of licences for the duty-free import of machinery would be suspended for the time being, but that the long-term problem involved would be examined with industry.

The committee comprises three industrialists with experience mainly as makers of machinery, three with experience mainly as users of machinery, a trade union representative and an independent. Chairman of the committee is Sir Henry Wilson Smith, a director of Powell Duffryn Ltd. Other members include Mr. T. F. H. Board (chairman of John Watney & Co. Ltd., director of other firms in the commercial distiller and chemical industries, and war-time Controller of Molasses and Industrial Alcohol) and Mr. C. H. Grist (joint managing director of Blaw Knox Ltd.).

The committee's terms of reference are: 'to consider and report whether it is in the national interest to provide for the duty-free admission into the United Kingdom of machinery, either by classes or in individual consignments; and, in this connection, to review the provisions of Section 10 of the Finance Act, 1932, and their administration, and to recommend what, if any, changes should be made.'

Communications concerning the committee should be addressed to the Joint Secretaries at the Board of Trade, Horse Guards Avenue, London, S.W.1.

A.M.I.Chem.E. examination

The next Associate Membership Examination of the Institution of Chemical Engineers will be held in September and December. Application forms, returnable

Our new address

The address of Leonard Hill Ltd., publishers of *CHEMICAL & PROCESS ENGINEERING*, is now:

Stratford House, 9 Eden Street, London, N.W.1

Telephone: Euston 5911

Will all correspondents please cancel our old address from their records and substitute the new one.

June 1, 1953, and full particulars are obtainable from the Secretary, Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1.

Mr. Leonard Hill re-elected chairman of S.C.I. group

Mr. W. Leonard Hill, chairman of Leonard Hill Ltd., publishers of *CHEMICAL & PROCESS ENGINEERING*, *Manufacturing Chemist*, *Food Manufacture*, and a number of other technical journals and reference books, has been re-elected chairman of the Agriculture Group of the Society of Chemical Industry. Besides his interest in agriculture as a publisher of the international journal *World Crops*, Mr. Hill is himself a farmer. His estate is at Crux Easton, near Newbury.

Solvent producers' reorganisation

As part of an internal reorganisation in The Distillers Co., Ltd. Group, Solvents Products Ltd., and British Industrial Solvents Ltd., ceased trading as separate companies as from April 1. The latter company is now being conducted as 'British Industrial Solvents—A Division of The Distillers Co., Ltd.'

The responsibility for all the outstanding commitments and liabilities of both firms is being undertaken by The Distillers Co., Ltd.

It is requested that any materials on order be delivered in accordance with instructions originally given by the two companies.

I.C.I. appointments

The Lime, Billingham, Alkali, Plastics and General Chemicals Divisions of Imperial Chemical Industries Ltd. have announced the following appointments:

Mr. L. B. Ryder has been appointed chairman of the Lime Division.

Dr. S. W. Saunders has been appointed a Billingham Division managing director (jointly with Mr. W. B. Scott) and Mr. D. M. Bell has been appointed to the Billingham Division board.

Mr. E. Henderson, Mr. G. W. Innes and Mr. G. A. Richmond have been appointed to the Alkali Division board.

Mr. F. Steadman has been appointed to the Plastics Division board.

Mr. S. B. Cormack and Mr. C. G. Harris have been appointed to the board of the General Chemicals Division.

Windsor staff changes

Mr. E. A. Norris, home sales manager of R. H. Windsor Ltd., manufacturers of machinery for the plastics industry, has now retired from active work in this post after 14 years' service with the company. He will, however, continue as technical sales consultant. Two farewell presentations to Mr. Norris were made at the company's works, one from the company and the other from executives and staff.

Mr. R. E. G. Windsor's brother, Mr. G. T. Windsor, has taken over the position of home sales manager for the company's products.

New factory for seaweed processing

A factory for the manufacture of cattle feed and fertilisers from seaweed has been opened by the Moray Firth Seaweed Products Ltd., at Kirkwall, Orkney. Output is estimated to be about 130 tons of meal per month, an equivalent of 500 tons per month of raw weed, which is at present being cut from the beaches near the factory.

Some types of seaweed are richer in protein and carbohydrates than others and the aim of the firm has been to obtain a mixture of various types blended to produce maximum digestible nutrients which can be fed to cattle, pigs, poultry, sheep, goats, horses or dogs. Aromatic herbs have been added to this product to improve palatability. Apart from the valuable trace elements it contains, seaweed has a higher food value than is normally appreciated. Starch equivalent is higher than in most hays and fibre much less, it is claimed.

The process used in this factory is briefly as follows: The weed is first fed into a drier, in which it passes, on a conveyor belt, through various levels of heat, from 600°F. to about 300°F., at the same time being subjected to powerful air currents. The weed passes next to the pre-breaker which chops it into small pieces and removes extraneous matter. From there it is blown through an inverted U pipe to the mill, where it is ground to meal by hammers revolving at 3,000 r.p.m. This meal is blown through a long horizontal pipe to bagging apparatus. The various types of meal are dressed and mixed in a chamber where foreign matter is riddled out. The finished product is then packed.

Consumer price will be about £23 per ton for fertiliser and £30 per ton for feeding-stuffs.

After meeting local requirements, the bulk of the meal will go to England.

The firm is also exploring the use of a special blend of seaweed meal in human food and have got to the stage of blending very finely ground powder made from many types of seaweed for this purpose. The powder is being tried out by various medical authorities and experts in nutrition, and prospects are encouraging.

New I.Chem.E. exam proposed

Young chemical engineers thinking of sitting for the examinations of the Institution of Chemical Engineers would be well advised to do this quickly as a completely revised examination which would probably raise entry standards was in prospect. This advice was given by Mr. Stanley Robson, president, speaking at the I.Chem.E. annual dinner in London on April 23.

The climax of Mr. Robson's speech and, indeed, of the whole evening, was his presentation of the institution's highest award, the Osborne Reynolds Medal, to Mr. J. A. Oriel, C.B.E. Until about 1950 Mr. Oriel was general manager of Shell Refining and Marketing Co., and he is still retained by Shell Petroleum Co. as an adviser. He has given long and distinguished service to the institution and is now chairman of the Nominations Committee which is revising conditions of entry. He was given a great ovation when he rose to accept the medal and make his speech in which he urged that youth should be encouraged to make careers in industry as one of the highest forms of national service.

New chairman for A.C.A.E. Chemical Group

Mr. Francis L. Waring, joint managing director of the 'Coalite' Group of Companies, and for some years an elected member of both the executive board and the chemical executive committee of the Association of Chemical and Allied Employers, was elected to the chair of the Chemical Group at the annual general meeting recently.

Annual dinner of S.C.I.'s Chemical Engineering Group

The Chemical Engineering Group of the Society of Chemical Industry held their annual dinner on April 10 in London. The guest of honour was the president of the S.C.I., Mr. Francis J. Curtis. In responding to the toast given by the chairman of the Group, Mr. H. V. Potter, Mr. Curtis discussed current chemical engineering progress in the U.S., his native country (see p. 131).

Mr. Potter's health was proposed by Mr. Julian Leonard, honorary treasurer of the S.C.I., who congratulated him on his successful two years' chairmanship of the Group. In reply, Mr. Potter urged members to make a greater effort to support the Group and to increase its membership.

End of Sulphur Committee

The Sulphur Committee of the International Materials Conference was dissolved on April 30 as a result of the improvement in world sulphur supplies.

CANADA

Citric acid

Canada's first commercial plant for the manufacture of citric acid, just put to work, has a capacity to meet the entire needs of the domestic market. This claim is made by the owners, Kembell, Bishop & Co. (Canada) Ltd., a subsidiary of the London firm of the same name. The factory has been erected on a 25-acre site in Cornwall, Ontario.

Full advantage has been taken of the latest technical advances in plant construction and the product will be available in many grades, complying with tests even more exacting than the British and U.S. pharmacopoeias and the Canadian food and drug laws. Acid in both the hydrated and anhydrous forms is being produced. It is the intention of the Canadian company to make other fine chemicals.

Big new synthetic fibre project

Imperial Chemical Industries Ltd. has decided to erect a plant in Canada for the manufacture of the new synthetic polyester fibre, *Terylene*. The expenditure on this project will be a sum in excess of 20 million Canadian dollars. It is the company's intention that the necessary finance shall be found in Canada in accordance with proposals which have been approved by the Bank of England.

The plant, which is planned to meet the full demands of the Canadian market, will be erected at Millhaven, near Kingston, Ontario. This location has been chosen because it offers distinct advantages in meeting the exacting technical requirements of the project. Options on suitable land have already been secured, and building and engineering teams will begin field work at an early date.

Construction of the plant will be initiated by a new wholly-owned Canadian subsidiary of I.C.I. After the proposed segregation of the I.C.I. and du Pont interests in Canadian Industries Ltd. it is intended to offer this project to that successor company of C.I.L., in which I.C.I. will be the principal shareholder and in which Canadians will participate as shareholders. This procedure is in accordance with I.C.I.'s policy of regarding the successor company as the normal medium for developing manufacturing projects in Canada.

A product of British research, *Terylene* was discovered in the laboratories of the Calico Printers Association Ltd. I.C.I. acquired the world rights (except in the U.S., where the fibre is being made and sold under the name of *Dacron*). The basic Canadian patent was granted in February of this year. I.C.I. has invested substantial sums in research and development on the fibre, and production in the United Kingdom on a pilot-plant scale started some years ago. The construction in the U.K. of a full-scale plant involving a large capital expenditure is well advanced.

Terylene fibre is sold in two forms—

filament yarns and staple fibre. In its staple form, Terylene fibre is very resilient and therefore is an attractive material for woollen clothing and suitings.

Nickel production research

The International Nickel Co. of Canada Ltd. states in its report for 1952 that oxygen flash smelting of copper concentrates, a major result of Inco research, was carried out on a commercial basis during the year. Also in 1952, large-scale production of liquid sulphur dioxide, obtained as a by-product from the company's oxygen flash smelting of copper concentrates, was initiated by Canadian Industries Ltd. in a new plant built at Copper Cliff, Ontario. The resulting output of this valuable chemical is expected to supply a substantial portion of the sulphur requirements of the sulphate pulp industry in Ontario and western Quebec.

Research activities continued on the development of an economic process for treating nickel-bearing pyrrhotite for the recovery of nickel and iron oxide. The high-quality iron ore obtained in pilot-plant operations has been employed in successful full-scale experiments carried out in co-operation with the steel industry.

The company's laboratories at Birmingham (England), Huntington (West Virginia) and Bayonne (New Jersey) gave top priority to the further development of high-strength alloys for jet engines.

Record sales. Net sales of nickel and nickel alloys, copper, platinum and other metals by the company in 1952 were worth \$314,228,747, compared with \$286,785,241 in 1951. Deliveries of nickel in all forms amounted to 249,017,358 lb., compared with 243,865,030 in 1951. Mill and foundry product deliveries increased by 13 million lb., much of which was in the form of nickel-chromium alloys for jet engines. Deliveries of copper totalled 234,323,432 lb., compared with 236,954,595 lb. in 1951. Deliveries of platinum-group metals were 287,135 oz.—88,000 oz. less than the previous year.

Capital expenditure amounted to \$19,315,391. The major expenditure during the year, as for a number of years past, was for the continuation of the company's extensive underground development programme. At the same time, rolling mill facilities in the U.S. and the U.K. were expanded and their outputs increased by more than 15%, and special plant projects, undertaken at Government request, were expanded or continued in both countries.

The company again expanded its exploration in search for new sources of nickel, the cost in 1952 being \$4,967,450 as compared with \$2,593,908 in 1951.

COLOMBIA

Distillation plant required

Industria Licorera de Narino, a liquor company in Colombia, is planning the construction of a modern distillery with a production capacity of 250,000 bottles of

20° alcohol in 720 hr. of continuous distillation with all installations complete, including improved packing equipment.

Firms interested in quoting on the distillery equipment should be prepared to install it and arrange a reasonable trial period of operation. The firm requests quotations in dollars f.o.b. port of embarkation.

In addition to the above, the company seeks quotations for a complete plant to extract essential oil of anise with a capacity to distil 5,000 lb. in 720 hr.

Interested firms should address correspondence to the manager, Industria Licorera de Narino, Avenida Santander, Calle 22, No. 29-43, Pasto, Narino, Colombia.

JAMAICA

Anhydrous alcohol to be made

The Sugar Manufacturers' Association (of Jamaica) Ltd. state that their subsidiary, Anhydrous Alcohol Ltd., propose soon to begin full-scale production of anhydrous alcohol from high-strength rum and/or alcohol for admixture with petrol. Output is estimated at 1½ million gal. p.a. The Government have been asked to enact legislation whereby the oil companies will take up to 15% of the company's yearly sales of anhydrous alcohol for admixture with petrol.

ADEN

Sea-water distillery

An evaporating and distilling plant capable of providing more than 1,700 tons of fresh water daily from sea water is to be built for the new Anglo-Iranian refinery at Aden by G. & J. Weir Ltd., Glasgow.

The order is for three triple-effect Weir evaporators and distillers. Work on the order has already commenced at Cathcart, and it is expected that the work of erection at Aden will begin early in 1954.

A large order was placed with Weir's in September last for evaporating and distilling plant to supply fresh water at Kuwait at the head of the Persian Gulf.

AUSTRALIA

Atomic research project

The Rum Jungle uranium field in Australia's Northern Territory will be in full production next year, according to Mr. Howard Beale, the Supply Minister. He told the House of Representatives that the Government had decided on a research and development programme leading to the industrial use of atomic energy. Ore would be produced this year and a treatment plant would be erected.

Mr. Beale introduced an atomic energy bill to create an Australian atomic energy commission and make special security provisions. He said the bill was made necessary by important discoveries of uranium ores, especially in the Northern Territory, and by the Government's determination that these deposits should be vigorously and promptly exploited for the defence of Australia and her allies and also ultimately for industrial purposes.

HUNGARY

Heat-resistant peat

A method of turning peat into a heat-resisting material has been devised by a group of Hungarian engineers who were asked to find a substitute for cork, which the country has to import.

The peat, of which Hungary has plenty, is cleansed of its soily constituents and impurities and then dissolved. To the solution is added about 5% artificial resin solution and resin soap. The mixture is then turned into slab form by a caustic process.

The new heat-insulating peat slabs have already been used for building cold storage plant in the new city of Szatánváros.

ITALY

Sulphur industry's doldrums

Conditions in the Sicilian sulphur industry have continued to deteriorate owing to high labour and raw material costs, and to foreign competition. Private estimates put unsold stocks at 10,000 tons of crude and 36,000 tons of processed sulphur. Because of this there has been talk of abolishing the export surcharge on processed sulphur and raising domestic prices by 5,000 lire/ton.

Meanwhile, provisional figures show that 1952 production was 217,000 tons of crude sulphur and 22,000 tons of ground sulphur against 200,549 and 22,475 tons respectively in the previous year.

SOUTH AFRICA

Limestone discovery

A hitherto unknown area of very high grade primary limestone has been proved to exist at Silverstreams, about 100 miles west of Kimberley, the Northern Lime Co. has announced. It said the discovery followed extensive investigations conducted by the Central Mining Investment Corporation. First grade limestone is said to be present on farms over which Northern Lime holds rights in sufficient quantities to satisfy South Africa's entire lime demand for many generations ahead.

Plans for development include the installation of a rotary kiln, the first of its kind in the Union, with an output capacity in excess of 100,000 tons/p.a.

BRAZIL

Caustic soda plant agreement

Contracts between French and Brazilian interests, guaranteed by the respective governments, have been signed for the building of a 45,000 tons/p.a. caustic soda plant at Cabo Frio, Rio de Janeiro. The French Comptoir International d'Achats et Ventes a l'Etranger is to grant the equivalent of a \$12 million loan for the necessary equipment to the National Alkali Co. which will own the plant. Furthermore, the Ste Krebbs de Neuilly-sur-Seine will install the facilities. Cruzeiro expenditure is to be met by a loan of 180 million cruzeiros from the National Bank of Economic Development.

CHILE

Government control of nitrate

A decree has been signed in Santiago which permits the Chilean Government to take complete control of any nitrate plant which ceases operations if, in the opinion of the President of the Republic, this might cause economic or social trouble and harm to the interests of the country.

The law is said to be aimed against the Tarapaca and Antofagasta Nitrate Co. which has been seeking tax relief in order to continue operating.

Cu from sulphide ores

The Chile Exploration Co. has officially opened a new plant to extract copper from sulphide ores and process the sulphide content of mixed ores. The plant will produce 19,500 metric tons of blister copper monthly. It was constructed by the Anaconda subsidiary at a cost of \$12 million.

Recovery of copper at Chile Exploration's Chuquicamata mine has previously been exclusively from oxide ore and the oxide content of mixed ore. The principal future production of copper will come from the new sulphide plant.

KENYA

New cement plant

A £1,500,000 cement works, capable of producing 100,000 tons annually, is to be built by the East African Portland Cement Company, a subsidiary of British Tunnel Portland Cement. Announcing this, the Government said the plant would be located on the Kenya coast near Sultan Hamud, about 100 miles south east of Nairobi, and that the company had agreed in principle to go ahead with construction.

INDIA

Cheap nicotine-from-tobacco process

What is claimed to be a cheap method of extracting nicotine sulphate from tobacco waste has been patented by the National Chemical Laboratory, Poona. Previous efforts to establish a process which could be used on a commercial scale had been unsuccessful owing to the low nicotine content (1-3%) of tobacco waste.

The tobacco waste is pulverised, mixed with lime and then extracted with a common salt solution. After stabilising, the resultant fluid is extracted with kerosine in a specially designed column. Nicotine is recovered from the kerosine solution by fixing it with dilute sulphuric acid.

Nicotine sulphate, which in its commercial form is a solution of 40% nicotine, is extremely effective as an insecticide and, in agriculture, is used in a concentration of 0.6-1.0%.

Firms most likely to undertake manufacture by the new process are tobacco curing companies who have adequate supplies of tobacco waste, or established fine chemical manufacturers situated in the tobacco areas.

Our Contemporaries

Articles published in some of our associate journals in the Leonard Hill Technical Group this month include:

Manufacturing Chemist—New Antibiotics Factory in Sweden; Tobacco Flavours; Modern Veterinary Medicaments, Part 3: Chemotherapeutic Control of Piroplasmiasis; pH and the Adaptation of Bacteria against Quaternaries; Hydrazine from Urea; Economic Poisons.

Atomics—Radioactive Isotopes in Medicine: Iodine; Cosmic Ray Research.

Building Digest—A New Neighbourhood in Mitcham; Aspects of the Soviet Architectural Style; A Cigar-Shaped Theatre in California.

Food Manufacture—Beechwood Factory of Brown Wills & Nicholson, Plymouth; The Vitamins, Part II; Lactic Acid Bacteria in the Meat Industry; Transport and the Food Industry.

Muck Shifter—Constructional Work for Stockholm's New Underground; Swedish Tunnelling Methods; The Care and Maintenance of Grab Chains.

Petroleum—Catalytic Reforming in the U.S.A.; Viscous Flow; Use and Abuse of Fuels; Electrification and the Modern Oil Refinery.

World Crops—The Rubber Research Institute of Malaya; The International Organisation for Research in the Rubber Industry.

Paint Manufacture—Swedish Research on Stirrers for Viscous Liquids; The Use of the Electron Microscope in the Paint Industry; Physical Properties of Nitrocellulose and Lacquer Performance; The Effect of Driers on the Properties of Alkyd Resin Finishes, Part 3.

UNITED STATES

New polyethylene producer

The Dow Chemical Co. is to take up the production of polyethylene, and negotiations for patent licences and technical knowledge have been made with Imperial Chemical Industries Ltd. The Texas Division of the company is to build plant facilities for polyethylene synthesis at Freeport and production is expected to begin within 18 to 24 months.

New nickel-plating process

A new chemical method for nickel plating, called the 'Kanigen' process, has been announced by the General American Transportation Corporation. It is said to provide plating equivalent to that achieved in electro-plating, but with from one-third to one-half the nickel.

The company is to build two new plants to utilise the process—one at East Chicago, Indiana, and the other at Los Angeles.

The process, requiring no electrolytic equipment, can be used to nickel-plate thermosetting plastic materials as well as various metals, including steel, copper, brass, bronze, stainless steel and aluminium, it is claimed.

A company official said the process could also be used to plate valves and other products which previously could not be plated successfully. Scientists with the company developed the process through

the reduction of nickel by the use of hypophosphites. The process had been found practicable for pieces of any shape or size. It had been applied successfully for interior coating of tank cars. The cost of plating with the new method was estimated at from 50 cents to \$1 for each mm. thickness of nickel per sq. ft.

New plant to extract sulphur from low-grade ores

The American Sulphur & Refining Co., formed 18 months ago to develop a process for the extraction of elemental sulphur from native volcanic sulphur-bearing ores, is now building its first commercial plant near Fillmore, California. Approximately \$1 million will be invested in plant and property and production will be 100 tons daily of 99.5% quality sulphur.

The company claims that its new process will enable it to extract pure sulphur from ores with a sulphur content of about 20% at a cost competitive with that of producing sulphur by the large companies on the Gulf Coast. It plans to sell the refined ore both in the U.S. and abroad.

Surplus of sulphur from petroleum

The U.S. petroleum industry will be producing substantial marketable surpluses of sulphur within a few years as a result of Government-aided expansion, according to the Petroleum Administration for Defence. Increased recovery from natural gas and refinery gases would result in surpluses of 108,000 tons this year and of 210,000 tons in 1954.

The industry became a net producer last year, when it produced 20,000 tons more than it used. In 1951, the industry used 27,000 tons more than it produced. Oil refineries use sulphur in the form of sulphuric acid.

Texas vinyl acetate project

Production of vinyl acetate will shortly be undertaken by the Celanese Corporation of America. Manufacture will be started at the Pampa, Texas, chemical plant of the organisation which came into operation last November. Construction of the additional facilities for the project is now under way, and it is expected that initial output will begin in the third quarter of this year.

Aluminium industry prospects

The U.S. aluminium industry will probably not be able to satisfy all demands for its products for some months to come, but, with increasing production capacity and contingent on the volume of military and stockpile demands, pressure on the civilian market should be eased in the later months of 1953.

This forecast was made in the 1952 annual report of the Aluminium Co. of America. The report goes on to say that both military and civilian demands have stimulated an expansion of the aluminium industry to an all-out record size. Since

1939, when total U.S. primary aluminium production was just over 163,500 tons, the production capacity of the industry has been enlarged nearly nine times. By the end of 1953 the nation's primary aluminium smelting facilities will be able to produce approximately 3 billion lb. p.a. Alcoa's share in the expansion programme will involve an investment of more than \$350 million. The production and distribution of aluminium is materially affected by Government control and military requirements. The company points out that, not only has aluminium been allocated under the Controlled Materials Plan, but production of aluminium fabricated items has been subject to Government directives.

A major factor in limiting the amounts of aluminium available in 1952 was the prevalence of drought conditions in certain areas. Water shortages in these areas seriously curtailed generation of hydro-electric power essential to aluminium smelting and severe setbacks in production resulted.

It is estimated that 1952 losses in primary production because of these water shortages amounted to more than 50,000 tons for the aluminium industry as a whole.

Nitrogen project

Grace Chemical Co. plans to start construction in May of its new \$19 million nitrogen plant near Memphis, Tennessee. Completion is expected during the summer of 1954. Nitrogen produced in the form of ammonia and urea will be sold both for industrial and agricultural uses. Grace Chemical is a wholly-owned subsidiary of W. R. Grace & Co.

Big new vacuum flasher

A giant vacuum flasher with a capacity of 55,000 barrels of reduced crude oil is to be built for the Standard Oil Co. of California by the M. W. Kellogg Co., a subsidiary of Pullman Inc.

The only other unit in the world equaling this capacity is a similar plant designed and erected over a year ago for the same company at their Richmond, California,

refinery. Part of a major refinery improvement programme at El Segundo, California, the vacuum flasher is scheduled to be under construction by July.

New powder metal

The Chrysler Corporation, of Detroit, has announced the development of a new powder metal claimed to be far more ductile than its predecessors. Called *steel oilite*, the new product is said to have properties comparable to those of mild carbon steel and to be suitable for finished machine parts such as gears, cams, brackets and lever arms. Components made from the product are stated to be capable of resisting pressures up to 70,000 p.s.i., compared with about 35,000 p.s.i. for those made from iron powder.

Tougher synthetic rubber

A new triple-jet mixing process is enabling the Copolymer Corporation, at their works at Baton Rouge, Louisiana, to manufacture what is claimed to be a tougher, longer-wearing and cheaper form of GR-S cold synthetic rubber. Known as *Carbex*, the efficiency of the new synthetic is said to result from a more thorough mixing of GR-S with carbon black.

A three-way jet nozzle throws out liquid GR-S, squirts into it a churned-up mixture of carbon black and water, and whirls them together in a blast of high-pressure steam. This results in a tougher product at a reduction in both initial and processing costs, according to an official of the Copolymer Corporation. In addition, tyres made of *Carbex* last 'at least 20% longer under the same road conditions' than those made of conventional GR-S, the manufacturers claim.

In a programme sponsored by the Office of Synthetic Rubber of the Reconstruction Finance Corporation, Copolymer pools the technical knowledge of eight companies in operating the Government-owned plant at Baton Rouge. The new process will soon be made available to the entire rubber industry. *Carbex* will sell 'somewhat cheaper' than standard GR-S.

MEETINGS

Institution of Chemical Engineers

May 9. 'The continuous hydrolysis of fats,' by K. Burrow, 3 p.m., Midlands Branch, The University, Edmund Street, Birmingham.

The Chemical Society

May 14. 'Structural relations of natural products,' by Sir Robert Robinson, 5.30 p.m., Chemistry Department, University College of Swansea.

May 29. 'The behaviour of hydrogen peroxide as a solvent,' by Prof. W. F. K. Wynne-Jones, 7.45 p.m., Chemistry Department, Trinity College, Dublin. Joint meeting with the Werner Society.

June 4. Ramsay centenary meeting, 7.30 p.m., Chemical Society, Burlington House, Piccadilly, London, S.W.1.

Incorporated Plant Engineers

May 13. 'Industrial applications of the thickness gauge,' by R. Y. Parry, 7 p.m., Welbeck Hotel, Nottingham.

May 18. Plant Maintenance Team's visit to U.S.A.: report by Colin Troup, 7.15 p.m., Radiant House, Bold Street, Liverpool.

May 29. 'Dust control,' by R. J. Pitt, 7.30 p.m., Imperial Hotel, Birmingham.

Royal Society of Arts

May 13. 'Training for science and technology,' by Sir Richard Southwell, 2.30 p.m., John Adam Street, Adelphi, London, W.C.2.

Institute of Metal Finishing

May 14. 'The metal finishing of non-metallic materials,' by H. Ashton, 7.30 p.m., Engineers' Club, Albert Square, Manchester.

May 18. 'Instrument for the determination of coating thickness: a review of commercial instruments,' by E. S. Spencer-Timms, 6 p.m., Northampton Polytechnic, St. John Street, London, E.C.1.

Scientific instruments. W. G. Pye & Co. have just published their *Catalogue H* of scientific instruments. This supersedes all previous issues and includes only those instruments in current production. Details of a number of new instruments are included as well as information on the already established products of this company. The catalogue embraces electronic and associated instruments, galvanometers, electrometers and accessories, general physics equipment, magnetic instruments, measuring microscopes, cathetometers and accessories, switches, clocks, watches, potentiometers, resistance bridges and boxes. Since some of the instruments catalogued are similar in appearance to others, the illustrations included are representative of the whole range.

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